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GENERAL MARTINEZ DE CAMPOS.

SPANISH general and statesman, born in 1824, the son of a brigadier-general, left the Staff School of Madrid with the rank of lieutenant, went through the campaign in Morocco in 1859 as a member of the staff of O'Donnell, and was then promoted to the rank of major. In 1864 he joined the army of Cuba as colonel, and he remained six years in that island. On his return to Spain in 1870 he was sent, with the title of brigadier-general, to join the Army of the North, which was engaged in repelling the Carlist rebellion.

After the abdication of King Amadeo he declined to give his adhesion to the new order of things, and made no secret of his antipathy to the republic. He was put on the retired list in 1873, and shortly afterward was confined in a fortress as a conspirator. From his prison he addressed to General Jobal, Minister of War, the well known letter in which he requested permission to go and fight as a private under the orders of General Concha, the Carlist forces in Navarre and the Basque provinces. This letter obtained for him his liberty, and he was sent to the Army of the North in April, 1874, to command a division of the 3d Corps. He took part in the engagements of Los Muñecos and Galdemes, which led to the siege of Bilbao being raised, and he was the first to enter the liberated city on May 1, 1874. When General Concha reorganized the Liberal army, Martinez Campos was appointed general in command of the 3d Corps. He fought at the head of his troops, on the 25th, the 26th, and particularly on the 27th of June, the day on which the commander-in-chief, General Concha, was killed in the attack on Monte Moru, near Estella. General Martinez Campos, besieged at Zurugay, on the same day, by the main body of the Carlists, opened a passage through the enemy's ranks, at the head of a column which numbered barely 1,800 men, and went to rejoin, at Murillo, the headquarters, where he was able to organize the retreat of the army on Tafoelu. Returning to Madrid, he continued to conspire almost overtly in favor of Don Alfonso, while Marshal Serrano, chief of the executive power, was operating against the Carlists. In conjunction with Gen. Jovellar he issued the military pronunciamiento of Sagunto, which gave the throne of Spain to Alfonso XII. The new government sent him into Catalonia, as captain-general and commander-in-chief of that military district. In less than a month he pacified the country, put down the Carlist bands, and took the command of the Army of the North. He brought the civil war to a close by the defeat of Don Carlos, at Peña de Plata, in March, 1876. The high dignity of captain-general of the army, which is equivalent to that of a marshal of France, was the recompense for his services. A year afterward he was appointed commander-in-chief of the army of Cuba, which the rebels had held in check for seven years. Under his leadership the Spaniards were uniformly victorious, but neither these triumphs nor the strategical talents of the commander-in-chief would have succeeded in bringing about the complete pacification of the island if the recognition of the political rights of the Cubans and new Liberal concessions had not satisfied the demands of the insurgents. On his return to Spain, General Campos accepted the portfolio of war and the presidency of the council (March 7, 1879) and endeavored to procure the fulfillment of the promises made to the Cubans, but not obtaining the support of the Cortes, he resigned, and was succeeded by Canovas, December 9, 1879. Early in 1881 the Conservative government of Senor Canovas was overthrown, and a coalition betweeen Sagasta and General Martinez Campos came into power, and retained it till October, 1883, when it resigned in consequence of being unable to obtain from the French government a satisfactory apology for the insult offered to King Alfonso by the Paris mob on his visit to Paris.

In 1888 he was elected president of the Senate. Subsequently he conducted the successful Spanish campaign in Africa, and negotiated a treaty of peace with the Moriscos.

GENERAL ARSENIO MARTINEZ DE CAMPOS.
GENERAL-IN-CHIEF OF THE SPANISH ARMY IN CUBA.

ECKLEY BRINTON COXE.

THE news that Hon. Eckley B. Coxe died on Monday morning, May 13, of pneumonia, at his home in Drifton, Pa., has been spread already by telegraph over this continent, and probably also beyond the sea, and has produced in innumerable souls a deep sorrow and sense of personal loss, coupled with a shock of almost incredulous surprise. There are men of such rare nobility, simplicity and sympathy of character that we cannot bear to think of losing them after we have once known and therefore loved them, and among such men there are some whose inspiring enthusiasm, tireless activity and intellectual and spiritual vitality are such that we do not, in fact, ever think of losing them. The very idea of death in connection with them seems incongruous and absurd; and when we hear that they have ceased from their earthly labors we can scarcely believe it possible. Out of our lives, at least, the consciousness of their presence and influence will not depart at the bidding of a mere obituary item. Such a man was Eckley B. Coxe, and in such a mood (only translated into the terms of an abiding faith that his splendid personality really could not die and has not died) I receive the tidings of his decease. A scanty outline of his career is all that I can furnish at this time.

He was born in Philadelphia, June 4, 1839; graduated in 1858 from the Pennsylvania University, and, after a post-graduate course in the mining department of that institution, spent several years abroad, studying at the Paris Ecole des Mines and at the Freiberg Mining Academy. Born to the inheritance of wealth, he presented an illustrious instance of the complete utilization of the advantages which wealth can give to a young man, when it does not demoralize and weaken him by taking

from ambition and industry the pressure of necessity. No student desperately seeking the means of livelihood ever worked harder than Eckley Coxe; and when, after his thorough preparatory training, he entered into active life, he was speedily recognized as the foremost of American mining engineers. In a summary of his work, I think the following features deserve to be emphasized as characteristic:

1. While thoroughly at home in the details of practice, he was always keenly alive to the value of scientific instruction, investigation and discussion.

2. Profoundly realizing that commercial and industrial progress is not only a necessity but a blessing, he included in his conception of such progress the elevation (not the pauperizing patronage) of workingmen.

3. His labors and interests as a capitalist and employer were never permitted to hinder personal friendship toward his employes, as well as toward those with whom his business brought him into contact. He sympathized just like a poor man!

4. Though overwhelmed with great responsibilities, he sought therein no excuse for the neglect of his duties as a citizen, and freely sacrificed time and thought to the public service.

The first of the above characteristics was illustrated early, in his elaborate translation of the treatise on mechanics by Prof. Weisbach, under whom he had studied at Freiberg. A comparison of the American edition with the German original shows the immense labor involved, not only in the mere translation of the text, but in the recalculation of mathematical operations, with regard to the different units of weight and measure required for English and American readers. This great labor was not only performed without hope of personal reward, but the book itself was published at considerable personal cost to Mr. Coxe, and I doubt whether he ever realized from it any pecuniary profit.

Another evidence of his high estimate of science (especially considered as the result of the interchange of knowledge and thought) was furnished when, in 1871, he united with Mr. Richard P. Rothwell and Mr. Martin Coryell to sign the circular letter which led to the organization at Wilkes Barre, in May of that year, of the American Institute of Mining Engineers. For six out of the first seven years thereafter he was a vice-president; in 1878 and 1879 he was elected and re-elected president, and after the latter date he served four years, in two terms, as vice-president again. His ability was recognized in the Societies of Civil and Mechanical Engineers, of which he was a member, and of the latter of which he was elected president in 1893. But I think it may be fairly said without offense that his most affectionate interest was centered in the Institute of Mining Engineers, which he had helped to found. His presidential addresses and numerous papers in the transactions of that society evince not only his professional ability, but also his interest in scientific and technical education. This was shown also by his maintenance at Drifton for many years of a technical school for the education of miners.

Toward workingmen his attitude was that of true brotherly sympathy and wise philanthropy. He heartily supported Mr. Gowan in the conflict which overthrew the reign of terror established by the Mollie Maguires in the anthracite region; and he condemned the tactics of the labor unions; yet in the long strike of 1871 the generosity of Eckley B. Coxe and his wife protected multitudes of families from starvation; and he and his brothers deserve the high praise of not only exhibiting in the collieries under their management models of mine engineering and machinery, but also offering in the dwellings, gardens, artesian wells, library, reading room, schools, churches, and other appliances of comfort and improvement provided for their employes, models of enlightened philanthropy.

Of this political activity I will say nothing here, except to note that the conscientious scruple which prevented him from taking his seat when first elected to the Pennsylvania Senate (on the ground that he had contributed money in a general way to aid his party in the campaign, and therefore could not take the oath required of him), while it made many smile at his sensitive regard for the letter of the law, the spirit of which he had certainly not violated, unquestionably increased the universal sense of his high standard of personal honor. Of course he was re elected by a unanimous nomination and an overwhelming majority; and after a creditable term of service he was chosen as chairman of the Pennsylvania Democratic delegation to the national convention of 1884.

In connection with the Geological Survey of Pennsylvania and the State investigation into the waste of coal mining, he rendered efficient service. The latter subject was one to which he gave much attention, and in the study of which he expended much money as well as time. In recent years he devoted himself ardently to the idea of diminishing the commercial waste of anthracite by effecting the economical utilization of the smallest sizes. His inventions and publications in this direction are of high value.

He had been for years, and was at the time of his death, a trustee of Lehigh University; and it was with his earnest support that Prof. Drown was called to the presidency of that institution. In a recent private letter he said that he was "now living only for two things: the first, Lehigh University; the second, the burning of small coal!" Could anything more happily express the width and the wisdom of his sympathies?

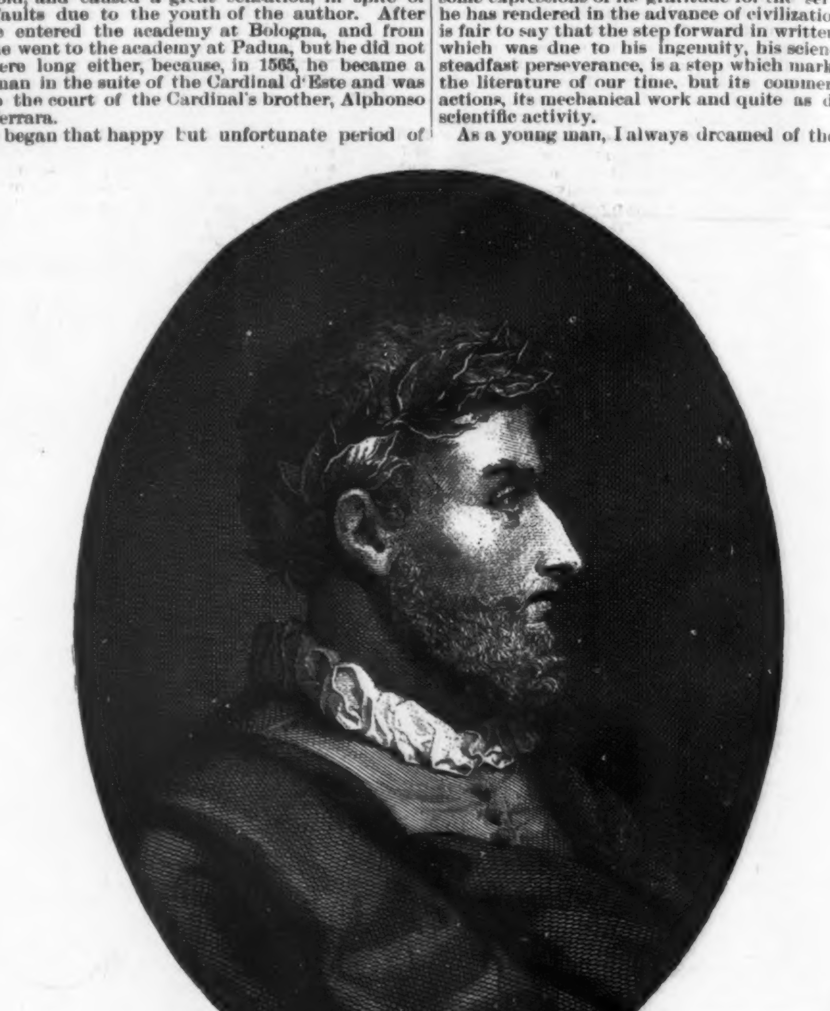
I can scarcely trust myself to speak of the personal charm which he exerted upon all who met him. The manly presence, the bright, glad, clear countenance, crowned with the curling locks tha seemed both to invite and to impart a blessing; the tumultuous utterance, in which language proved too slow a vehicle for the eager soul; the cordial smile and hand clasp that expressed a real and deep delight in friendly intercourse; the instant generosity; the perpetual boyish enthusiasm—who can forget them, that once has seen and felt them, or who can realize their magnetism that never saw or felt?

We members of the Institute of Mining Engineers have cherished always as a type and standard the memory of our "bright particular star," Alexander L. Holley; and we could not easily admit to companionship with his name in our hearts the name of any other man. But I dare to say of Eckley Coxe that he is worthy, by reason of his character and of our universal love, to be ranked with Holley, forever dear and unforgotten.—R. W. Raymond, Eng. and Min. Journal.

TORQUATO TASSO.

TORQUATO Tasso was born at Sorrento, May 11, 1544. His father, Bernardo, who belonged to a well known noble family, was distinguished not only for his poetic talent, but also for his great intelligence, his strong and upright character, and his worldly wisdom; in fact, for all the qualities that were lacking in his son, who was, however, a much greater poet. He was in the service of the Princes of Salerno, and was obliged, for political reasons, to fly from his native land in 1547 and enter the service of the King of France, leaving his wife, son and daughter in Naples. Torquato was thus deprived of his father's guidance during his childhood. He was highly gifted, a precocious child. When ten years old he was allowed to go to his father, who was then at the academy of Vicenza, and who, thenceforth, directed his son's education. Bernardo recognized his son's remarkable poetic talent in the assistance he received from him in the completion of his own poem "L'Amadigi" and in the beautiful ode which the twelve year old boy composed after the death of his mother, but he considered it wisest to keep him at other studies, not allowing him to devote himself to poetry until after the publication of his romantic poem "Rinaldo," which appeared when he was only eighteen years old, and caused a great sensation, in spite of many faults due to the youth of the author. After this he entered the academy at Bologna, and from there he went to the academy at Padua, but he did not stay here long either, because, in 1565, he became a gentleman in the suite of the Cardinal d'Este and was sent to the court of the Cardinal's brother, Alphonso II of Ferrara.

Here began that happy but unfortunate period of



TORQUATO TASSO.

his life that Goethe described so wonderfully in his "Tasso." Already famous, although only twenty one years of age, handsome, talented, amiable, the young poet took the court by storm and was thoroughly spoiled by it. Alphonso and his two sisters made much of him, the Princess Eleonora taking particular interest in his work and advising him about his great poem "Gerusalemme liberata." The whole court imitated their superiors in their attentions to the young poet, and it is not surprising that he became haughty and arrogant.

In 1569 Tasso lost his father, and two years later he accompanied the Cardinal d'Este to Paris, where he received great honor from the king, Charles IX, and also from the French poets and savants. After his return to his native co ntry he left the service of the cardinal, who he thought did not appreciate him, and entered the service of his brother Alphonso under most favorable and profitable conditions, so that he was enabled to devote himself entirely to writing.

At this time he completed his most graceful and brightest work, the pastoral drama "L'Aminta," and he also finished his most celebrated work the "Gerusalemme liberata," above referred to. This was first published, without his consent, in 1581, after he had been put und r restraint, and it passed through more than one hundred editions. It has also been translated into all living languages.

At the time of its completion it was circulated only in manuscript form, and, of course, met with adverse as well as favorable criticism. This he should have expected, but he had been so spoiled that he could see nothing in this unfavorable criticism but envy, intrigue and premeditated insult, which made him hate Ferrara and feel that he was surrounded by enemies. He quarreled with every one, and although treated with great clemency by the duke and his family, the feeling of persecution grew until he imagined himself in constant danger from poisoning and assassination, and he was also assailed by religious doubts It became so evident that the unhappy poet was insane that it was thought necessary to place him where he could have medical treatment, and he was finally sent to the hospital of Santa Anna.

He remained there almost eight years, but the Prince of Mantua succeeded in freeing him in 1586. He followed the prince to Mantua, where he was overwhelmed with kindness, but even there he was suspicious and discontented, and in 1587 he went to Rome, where he completed his "Gerusalemme conquistata." After having been crowned in the capitol, the highest honor a poet could receive from the Pope and the Roman Senate, he sought refuge, on account of illness, in the cloister of San Onofrio, near Rome, where he died April 25, 1595, at the age of 51.—Illustrirte Zeitung.

[FROM BOSTON COMMONWEALTH.]

THE EVOLUTION OF SHORTHAND.

THE death of Mr. Isaac Pitman, the pioneer of the system of shorthand to which he gave the name of phonography, recalls the English-speaking world to some expressions of its gratitude for the service which he has rendered in the advance of civilization. For it is fair to say that the step forward in written language which was due to his ingenuity, his science and his steadfast perseverance, is a step which marks not only the literature of our time, but its commercial transactions, its mechanical work and quite as directly its scientific activity.

As a young man, I always dreamed of the possibilities open to the future in more rapid writing than that which we were all chained to under the imperfect systems of shorthand of the past. My attention being thus called to it, I think it worth while to mention in print my own recollection of the fact that President Fillmore used the service of a shorthand writer in his daily work at the White House, and that he is the first public officer of whom I remember to have heard this said. I have some quite large collections of John Quincy Adams' correspondence when he was President, and I know that he wrote long letters with his own hand. The truth is that most public men, used to writing, dislike the dictating to an amanuensis who must employ longhand. There is little good in dictating unless you save time.

I was in the army with General Butler in 1864, and I know that it was considered then as somewhat of a novelty that he employed the services of shorthand writers in dictation.

It was in the revolution thus established in almost every large counting room, and in the work room of almost every man of letters, that Pitman's great improvements have really revolutionized the methods of our modern life. General Butler would easily turn off one hundred letters in a day in his voluminous correspondence. It may be said in passing that the practical fault of his administration in everything was that he chose to take other people's business on his shoulders; and he wrote many a letter which belonged to the heads of the different departments on his staff.

To the outsider, who only needs to write enough to order his coal from the wharf or to thank his friends for the sample copies of their new magazines, it is a matter of little interest how this revolution was effected. To the young generation, it will seem impossible that the essential principles of Pitman's reform

were not observed long before. Shorthand was used in Rome in Cicero's time. We do not really know much about their shorthand. From a very early date it has been used in modern times, and there are hundreds of quaint, old-fashioned systems, which it has been the duty and penalty of some of us, for our sins, to study.

It is clear enough to anybody who makes the letter w in ordinary writing that he would save time if he made that letter by a single stroke, straight or curved, and different arrangements by which this can be done fill the little book called La Plume Volante and others with similar fanciful names, which belong in the earlier history of shorthand.

It would very soon appear that the omission of the vowel in most instances saves time, and that the record is tolerably intelligible without it. Let the reader take any sentence with which he is more or less familiar, let him write it without the vowels, and he will see that on the whole he can make out the sense. Certainly he will do so as long as his memory of the subject is fresh.

On these two observations, which we can hardly call discoveries, the earlier shorthands are all founded. The different experts who made them seem to have had a passion for varying each from the custom of his predecessor. It was easily enough observed that it would be best to use a straight line, which is so simply made, for the consonant which occurs more frequently. And it was easy to see that the straight line can be made in four ways; it can be horizontal, it can be vertical or it can slant from right to left or from left to right.

It was easy to see that four curves, each of them the half of a circle, were made almost as quickly as the straight lines. It is as easy to see that the circle might be divided into four quarters, and this would give four more signs. Equipped with these twelve signs, the different writers of shorthand arranged them in alphabets, very much by their fancy, but holding the general feeling that a straight line is made more rapidly than a curved one.

The object to be attained is to write as rapidly as a man speaks. In point of fact, it is observed that in very slow public discourse the speaker may use as few as sixty words in a minute; on the other hand, it is possible for a very rapid speaker to use one hundred and eighty words in a minute. We take these figures from Chambers' Encyclopedia. Now as no one can make even dots resembling each other, where he is obliged to take up the pencil from the paper for each dot, with a rapidity much greater than the most rapid speaker can use, it would seem at the first moment as if it were impossible for the reporter to have as many signs upon his paper at the end of five minutes as the very rapid speaker can give. The reporter, however, is relieved here by one or two incidental helps. First and chiefly, no man in public address long speaks on the rapid flow of one hundred and eighty words in a minute. It may be said, perhaps, in passing, that if he does, what he says is not worth reporting. Of course, also, the reporter is supposed to have some sense, and can readily relieve himself by signs which show that a particular passage has been repeated, or he can fill out by his own intelligence language which is, after all, almost purely mechanical. The old shorthand writers dealt with their problem by the use of such helps as these, and we have very remarkable results of their success in reporting the speeches of their day.

Anybody who remembers Dickens' amusing account of the shorthand training of David Copperfield will remember that, while he wrote his text with sufficient ease, he found great difficulties in reading it. There is really no exaggeration in what Dickens says, and in this brilliant little passage he gives the account of the limitation of the old shorthand, and the reason why it did not take its place either in the cabinets of statesmen or the working rooms of men of letters.

To this arbitrary system, of use only in such departments as reporting for the press and possibly a few other contingencies, Mr. Pitman put an end. I should say that his real contribution to the business was the very simple division of his signs according to the characteristics of the different consonants. The linguals, for instance, T and D, because they are linguals, are represented by the same signs, one with a heavier impact of the pencil than the other. P and B, in the same way, are represented by the same sign, one with a heavier impact than the other. By this simple device, Pitman gained available characters, as I think no shorthand writer had done before him.

Better than this, however, his very ingenious device, by which a character written above the line has one significance, another significance when written on the line, and yet a third when written below the line. Here was a device which no previous inventor has used to anything like the extent which he does.

Without going more into detail, it is enough to say here that Mr. Pitman invented a system which, when it is employed by an expert, can be read as easily as it can be written. This can be said of none of the old systems of shorthand. Nor would any one using any of the old systems dare to say on oath that the system represented absolutely the words which were spoken, as the printed line before the reader's eye represents the words which I have written.

Gaining this, Mr. Pitman gained everything. He had before him long years of stupidity, he had before him the arrogance of the educated classes, he had to meet the deaf and dumb and blind unwillingness of England to change any habit which had been established; but in a life of sixty years he has had the pleasure of seeing, first, hundreds of people who have stolen his ideas and adopted them in other systems; and second, and what probably repaid him fully for all, the introduction of a new method of communicating thought—a method which relieves intelligent people from a slavery which the next generation will hardly be able to make real.

Mr. Pitman accompanied his gospel of phonography by urging the system of reform in spelling for which he claimed the name of phonetics. This reform, if it be a reform, is one of the very unpopular "movements" of any age. The learned class of any community always dislikes to change the machinery to which it is accustomed.

In Mr. Pitman's case, the evident good sense and success of his phonographic system were handicapped by the prejudice against all that was said in favor of fonetix.

In his old age, however, Mr. Pitman has received some tokens of public honor for his success in phonography, and I should be sorry not to recognize my own personal sense of obligation to him in the columns of the Commonwealth. EDWARD E. HALE.

THE MINING INDUSTRY OF BOLIVIA.*

THE mineral wealth of Bolivia includes silver, copper, tin, antimony, bismuth, gold and borax. Silver is the most important, the amount shipped in 1894 not falling short of 15,000,000 ounces, while the total output of the mines was about 22,000,000 ounces. One-fifth of the total production has to be delivered to the government for coinage purposes. Difficulties of transport have prevented many mines containing rich ores being worked. The railway communication to Oruro will, in part, remove these obstacles, and we may shortly expect to see the annual output very largely increased. The greater portion of the copper exported is obtained from the Corocoro district, and is shipped in the form of barilla. It is found in soft freestone, crushed in a most primitive manner, washed, packed in bags, and sent to Mollendo, by way of the Desaguadero River and Lake Titicaca, for shipment to Europe. The copper is of fine quality, and the ores shipped average from 80 per cent. to 85 per cent. of pure copper. There is ample scope for large development of the industry. Next in importance to silver comes the tin industry. The deposits of this mineral are undoubtedly very rich. On this subject I quote an article written by Mr. John B. Minchen, a resident in Oruro. He says: Tin ore is met with at frequent intervals along the eastern border of the Bolivian table land, from the neighborhood of Lake Titicaca to near the southern boundary of the republic. The richest and most important portion of this zone is, however, undoubtedly comprised between latitude 17° and 19°. The general formation is slate or shale, usually highly inclined and distorted by eruptions of trachytic porphyry or other igneous rocks, the tin ore occurring in these latter. The conditions under which it is met with are, however, by no means uniform, either as regards the extent of the deposits or the class of associated minerals. Occasionally, as in the silver mines of Oruro and Potosi, it is more or less intimately mixed with iron pyrites and ores of silver; in other and the majority of cases, it is more or less pure, forming the chief characteristic of the lodes.

In some instances the deposits are to a greater extent superficial; in others they have been followed to depths of 1,000 feet and still continue.

The width of the veins, or lodes, is also variable, ranging from one or two inches up to six or eight feet. In the tin mines proper the ore is frequently very pure, containing 40 per cent., 50 per cent. and even 65 per cent. of the metal, though in such cases the width rarely exceeds two feet; in other cases, almost pure tin oxide occurs in the form of crystaline grains and nodules in a matrix of tenacious clay, or in a ferruginous mass, forming the bulk of the lode, which then often presents a width of from six to ten feet.

In the mines worked exclusively for tin, depths of 600 feet have not as yet been exceeded. The ore in some of these continues rich in the bottom, while in others it gives place to pyrites carrying more or less tin.

The excessive freights to and from the Pacific coast have hitherto greatly retarded the development of the Bolivian tin mines, increasing the cost of ore exported, and rendering difficult the importation of suitable machinery, the down freights reaching £12 to £14 per ton, and the up freights £20 to £24.

Another evil hitherto has been the insignificant amount of capital in the country available for the industry, and the disinclination of foreigners to make any considerable investment in a region laboring under such disadvantageous conditions.

The miners have been, almost without exception, in the power of the merchants, who, to counterbalance the risks which they undoubtedly run, contract for the delivery of ore at low prices, charging at the same time a high rate of interest on all advances, the result being that only the richest mines, or those most favorably situated, have been able to avoid sooner or later a state of bankruptcy. The completion, however, to Oruro of the Antofagasta railway is already producing a most beneficial effect. Deposits hitherto untouched and mines worked in a desultory manner with little or no profit will undoubtedly now be taken in hand and may be expected to pay well, while those at present in production will largely increase their output with the aid of grinding and concentrating machinery.

Water power is not usually available in the immediate vicinity of the mines, and the primitive methods employed for grinding the ore by manual labor under rocking stones, or with small edge runners worked by mules, do not admit of any reasonable amount being treated.

Hitherto only the richer classes could be touched, anything below ten per cent. or fifteen per cent. not paying expenses; in many of the mines, consequently, large quantities of such poorer ores have been left untouched that with cheap grinding would be available.

Some of the more important lodes of the Oruro† silver mines are composed of iron pyrites from one foot to six feet wide, and frequently containing from five per cent. to twenty per cent. of tin oxide associated with ores of silver and interspersed through the mass. In such cases the tin forms a valuable by-product, being extracted with but little extra expense by simply washing the tailings after treatment by the amalgamation process for silver. This washing has hitherto been commonly effected by hand, the tailings being fed in at the head of slightly inclined channels one foot wide, and some six feet or eight feet long, supplied with a moderate stream of water, the material being constantly raked up and turned over by means of a small thin board; the lighter earthy portion is gradually separated and carried off, the tin oxide finally remaining of a lye of 65 per cent. to 70 per cent., when it is dried and sacked for export. Common hand buddles are also employed, and of late Frue vanners have been introduced with fairly satisfactory results, though the unequal feeding by hand is objectionable.

The concentrated tin ore, or barilla, is also smelted on the spot with charcoal in small vertical blast furnaces and run into fifty pound slabs.

The loss, however, is not less than twenty per cent.; consequently in the Oruro district but little is reduced. From Potosi, owing to higher freights to the coast (£18 per ton), all the tin is exported in the metallic form.

Toward the northern part of the Bolivian tin zone, what promises to be an important deposit has lately been opened in the La Paz Cordillera, on the base of the snow peak Huaina Potosi.

The ore is possibly superficial, but it is of the finest quality, a rough grinding and washing raising it to a lye of 70 per cent. to 73 per cent.

Further south, in the Cordillera of Quimza Cruz, lodes of tin exist, especially at high altitudes near the snow line. They have been worked at intervals, but, owing to the difficulties of transport, hitherto with but little profit.

Following these are the Colquiri silver and tin mines, which have at times given a large production, and which, with increased facilities, will no doubt prove important. Still further south the richest tin district is encountered in the hills and ranges immediately to the east of Oruro and Lake Poopa, where the mines of Negro Pabellon, Villacolla, Morococala, Huanuni, Llallagua, Challa, Apacheta and Avecaya follow each other at short intervals.

All these mines are situated at an altitude of some 14,000 feet above sea level, and they contain well defined lodes of fine ore which occasionally attain a width of two feet, with a lye of sixty per cent.

In Negro Pabellon tin-bearing pyrites has made its appearance at a depth of 200 feet, while in Morococala the same depth has been reached without as yet any change.

The Huanuni district has for many years been the most important tin mining center. A conical mountain, Pozoconi, rising some 1,800 feet above the level of the adjoining ravine, is traversed by a multitude of lodes and veins, which have been largely worked. While many of these, at depths of from 100 to 200 feet, run into tin pyrites, in one of the principal lodes crossing the summit of the mountain the pure ore has been followed down for 600 feet without alteration.

Most of the lodes in Negro Pabellon, Morococala and Huanuni present continuous veins of solid tin stone, of variable width up to some two feet, and under these circumstances, as might be expected, some difficulty is experienced, owing to the extreme hardness both of the vein itself and of the adjoining rock; but seams of clay containing interspersed nodules and grains are also met with, and are worked to advantage, while from the tin bearing pyrites the ore is extracted by calcination in ovens and subsequent grinding and washing.

The Challa-Apacheta mines are situated about ten miles south of Huanuni, the lodes traversing low hills, rising some 250 feet above the neighboring ravine. One of these lodes is remarkable as possessing the unusual width of from 25 feet to 30 feet, the tin ore, in the forms of grains and sand, being so thickly interspersed through a slightly argillaceous matrix as to give a mean for the whole mass of some twenty per cent. This lode has been exploited horizontally over an extent of 250 feet, and to about the same distance vertically below the surface. When pyrites are encountered, the lode is extremely soft, the contents being worked out with pick and shovel at a low cost. It requires, however, a certain amount of grinding to reduce the tin particles to a uniform size, and admit of satisfactory washing on the vanner. What appears to be a continuation of the same lode is met with in an adjoining hill, but under very different conditions. It is here a comparatively narrow hard vein from 12 inches to 18 inches wide, in parts very solid, but with more or less admixture of pyrites, requiring calcination before grinding. This calcination is effected in heaps in the open air, a very small amount of fuel at the base being sufficient to start combustion, which is then maintained by the sulphur present.

One of the most important and productive tin mines at the present time is that of Avecayo, situated in a lofty mountain at the southern extremity of the Oruro tin district. The lodes are from one foot to three feet wide, giving considerable masses of solid ore averaging some forty per cent. of the metal.

The mining district of Berenguela is situated about forty-five miles east of Oruro, on the heights, immediately south of the Arque Quebrada. It was extensively worked by the Spaniards, but chiefly for silver, in which many of the lodes appear to have been rich. Those containing tin are distinct, and nearly virgin. The tin oxide occasionally occurs massive and pure, but for the greater part exists in the form of minute grains, interspersed through a ferruginous and siliceous matrix from three feet to six feet and even nine feet wide. This substance is soft and easily broken down with the pick at a trifling cost, but requires fine grinding for the satisfactory extraction of the tin.

Several samples examined showed much uniformity of composition, giving seven per cent. of metallic tin. On grinding with water, some fifty per cent. of the earthy matter is almost immediately carried off, when the residue, consisting of siliceous particles, requires further stamping to reduce it. On washing, the tin oxide remains as a fine sand.

Tin from the Berenguela district is said to be of a superior quality to any other mined in Bolivia. A fine, permanent water power, suitable for Pelton wheel or turbine, exists at a distance of 800 m. to 1,000 m. from the mines.

The tendency of tin ore to degenerate into pyrites is again illustrated in Berenguela, where, in one of the mines, this change occurs at a depth of 150 feet.

In addition to the deposits already mentioned many others exist, though hitherto of less importance, while the ravines descending from some of the mines, such as Negro Pabellon, Morococala and Huanuni, are more or less rich in stream tin, and have been to some extent worked, the washed product giving 62 per cent. to 68 per cent.

The celebrated silver mines of Potosi have for many years furnished considerable quantities of tin, which has also been worked of late years in the Porco. The conditions under which it occurs appear to be very similar to those met with in Oruro.

The total exportation of concentrated tin ore from Bolivia at the present time is probably not above 400 or 500 tons per month.

* From a report on the trade of Bolivia by the British consul at Lima.

† A description of the Oruro district appears in the Engineering and Mining Journal, April 23, 1892, page 447.

A PORTABLE SINGLE RAIL SURFACE RAILWAY.

As a general thing, the stability of railways of all kinds is a condition essential for their operation, and small portable railways themselves cannot escape this fundamental condition, which frequently passes unobserved in the projects for their establishment.

In most cases, however, portable tracks are laid upon the metaled ground of public roads, etc., that constitute a bed quite sufficient to assure their stability.

When they are employed in the work of excavation it is easy by reason of the very nature of such work to prepare the surface for the laying of the track and to

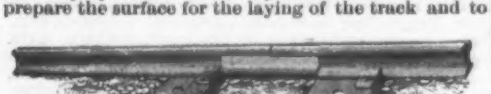


FIG. 1.—VIEW OF A RAIL JOINT AND FISH PLATE.

establish a platform that the laborers can keep in order without much expense.

For field work, the preparation of the surface, when that is necessary, involves an expense of establishment that is renewed at every displacement of the portable track. If, on the contrary, the railway is to be established permanently, it becomes indispensable to level the surface and constitute a platform sufficiently well prepared to resist the destructive action of the elements. It is necessary, besides, to carefully keep the bed thus prepared in good repair and to prevent the partial subsidences of the ground in order to have the track preserve that horizontality that is indispensable

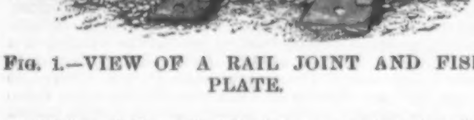


FIG. 2.—SWITCH.

for the operation of small portable railways and for the stability of the cars.

The leasing of the land and the keeping of it in condition constitute a complication and difficulty so much the greater in proportion as the line is longer. It is therefore fortunate for us to be able to make known a new system of carriage by rail, essentially portable and not requiring the same conditions of establishment and of stability of the ground.

In this system, as the track does not have to assure the equilibrium of the vehicles, it is not necessary for it to possess perfect stability, and it may be placed upon the ground in any position, without breakages

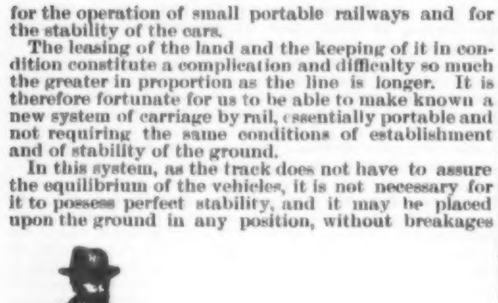


FIG. 3.—PLATFORM CAR.

or distortions being feared, and without ceasing to be perfectly accessible to the vehicles that traverse it.

The system consists of a single rail laid upon the surface of the ground. The rail usually employed is of the Vignole type, weighs 10 or 15 pounds to the yard, and is 23 feet in length. A rail provided with chairs attached to the foot without bolts constitutes an element of the track. The weight of an element is about 60 pounds.

In order to form a line, the elements of the track are placed end to end and united by means of a special fish plate (Fig. 1). These plates are not adjusted to the rails, but, on the contrary, allow of sufficient play

FIG. 4.—PLATFORM CAR.

to facilitate the mounting. It is not necessary to fix them to the rails by bolts; so the rails are not perforated, and a cause of weakness is thus avoided.

If it is desired to fasten the plates to the rail in order to give more fixedness to the track, small wooden wedges are driven into the interstices of the plate in order that the rail may be held more firmly in the latter.

In order to gain ground toward the right or left or to turn to the right or left, elements that have been previously curved are employed. Curves of wide radius are obtained by a simple deflection of the line in utilizing the play of the rails in the fish plates.

Shunting at crossings and other points is easily ef-

FIG. 5.—BARROW CAR UNLOADING.

fected by means of a very simple arrangement that may be maneuvered by the foot (Fig. 2).

When one line is to cross another one, there is installed at the crossing point a plate upon which are fixed in a stellate manner four lengths of rail ending at the track in each direction, leaving in the center of the star thus formed a free space sufficient for the passage of the flanges of the wheels of the vehicles.

The vehicles designed to run upon the track naturally possess very peculiar arrangements by reason of the special character of the line. Their general aspect may

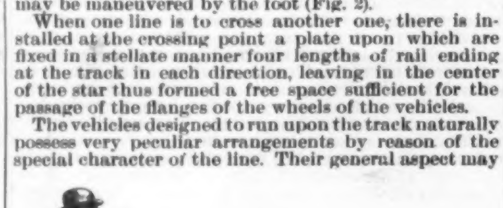


FIG. 6.—BARROW CAR.

be seen from the various figures that illustrate this article. In all of them we find two flanged wheels placed in the same vertical plane like the wheels of a bicycle, and a lever placed at the side of the apparatus to keep it in equilibrium while running.

The dimensions of the vehicles are very variable, from the small ones (Figs. 3, 4, 5 and 6) forming hand barrows that allow a man to handle 600 pounds of earth at a time more easily than he could carry a hundred pounds with an ordinary wheelbarrow, up to

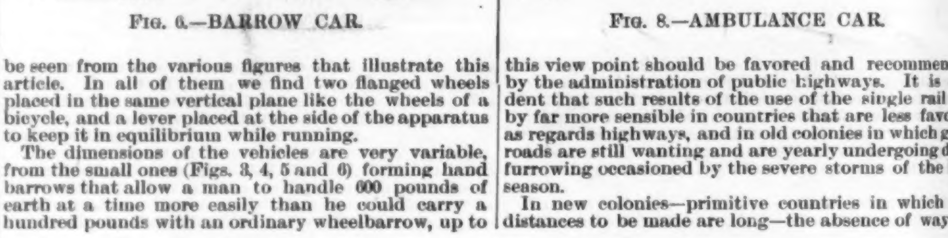


FIG. 9.—JOINTED TRUCK FOR THE CARRIAGE OF LOGS, RAILS, ETC.

the vehicles (Figs. 11 to 17) for carrying loads of from 2,000 to 4,500 pounds.

The various models of the vehicles necessarily depend upon the uses that are to be made of them.

The uses of the single rail material are multiple. It is easy to pass them rapidly in review in briefly indicating the material best adapted and most advantageous for the different purposes.

The single rail railway, being light, easily manipulated, and easily laid and taken up, is of practical use for manufactories, farms, gardens and vineyards, and for all work that is performed by wheelbarrow. The vehicles represented in Figs. 3 to 6 are well adapted for such purposes and permit a laborer to do much more work without any increase of expense and with less fatigue.

For agricultural purposes the large sized vehicles (Figs. 11 to 17) may be used. The single rail may be placed without incumberment upon farm roadways

FIG. 7.—AMBULANCE CAR.

and through fields for the gathering of crops, forage and roots. The lightness of the track and the mounting of it without precision render possible the frequent displacements necessary for the execution of the work, which is accomplished with economy and rapidity by means of rails laid across the fields.

On another hand, such a railway established at the side of highways divests transportation of the numerous difficulties resulting from the subsidence of the roadbed, which is always followed by an enormous increase in the cost of exploitation. The same advantages offer themselves to the same degree for industrial transportation, in which roadways are used for reaching shipping stations. The use of the single rail upon roadways is a safeguard for their preservation, and from

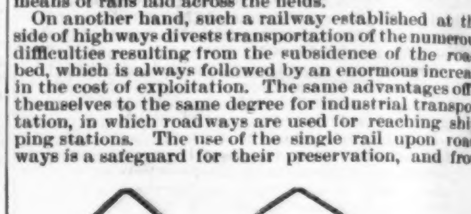


FIG. 8.—AMBULANCE CAR.

this view point should be favored and recommended by the administration of public highways. It is evident that such results of the use of the single rail are by far more sensible in countries that are less favored as regards highways, and in old colonies in which good roads are still wanting and are yearly undergoing deep furrowing occasioned by the severe storms of the bad season.

In new colonies—primitive countries in which the distances to be made are long—the absence of ways of communication almost completely trammels enterprises and exploitations of all kinds. It must be recognized in the first place that an almost insurmountable difficulty is met with in the establishment of means of transportation in these countries, which are destitute of resources for the execution of public works, because they are unproductive and remain so despite their natural riches, owing to the very fact of possess-

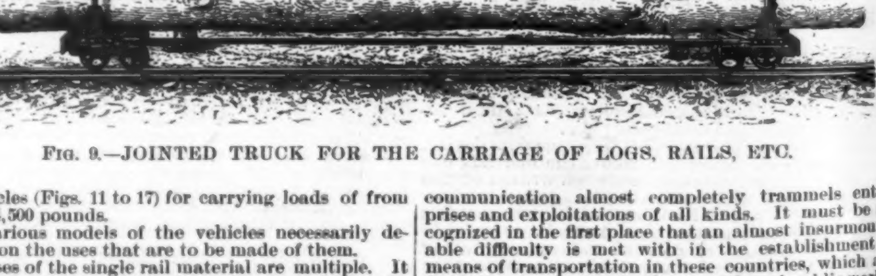


FIG. 10.—ELEVATION OF A PASSENGER CAR.

ing no such means of transportation. Undoubtedly, the metropolis ought to pay the cost of the first roads indispensable for commencing to make these colonies of value, but the multiplicity of the roads to be thus created, their considerable extent and the amount of money to be expended first for their establishment, and subsequently for their maintenance, constitute an obstacle that it has not been possible to overcome up to the present.

It is no exaggeration to say that the use of the single rail for such transportations in the colonies would constitute a considerable progress and put an end to a deplorable state of things.

Finally, the constituent qualities of the single rail system designate it very naturally for the service of military expeditions in the colonies. Its use is indicated for the creation of a temporary railway behind columns that are advancing into the interior of districts deprived of roadways. From this point of view, the organization of a single rail line composed of successive echelons of a feeble extent, connected with each other by a chain of relay posts, is capable of overcoming the greatest difficulties, which for every long expedition are those of transportation of material, of food, and of the sick and wounded.

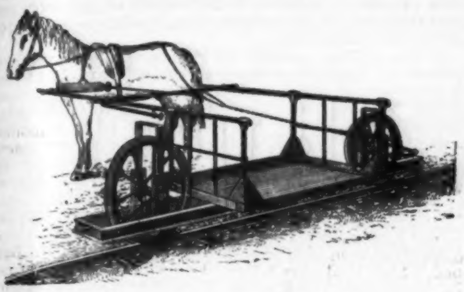


FIG. 11.—PLATFORM CAR.

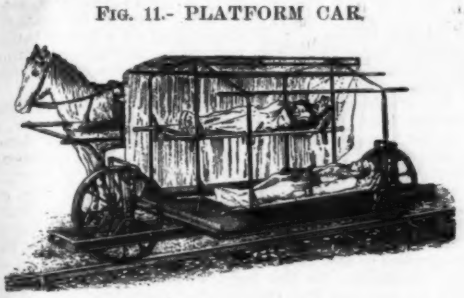


FIG. 12.—AMBULANCE CAR.

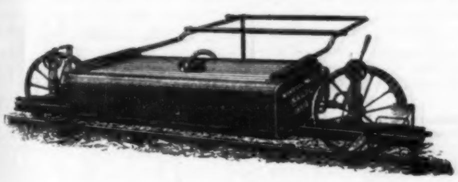


FIG. 13.—RESERVOIR CAR.

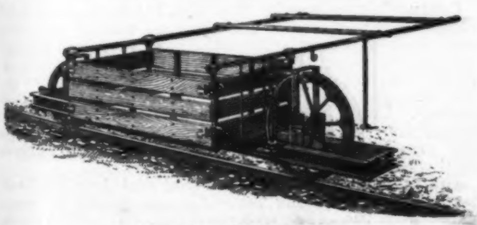


FIG. 14.—BOX CAR.

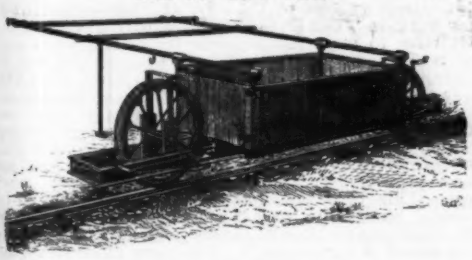


FIG. 15.—TUMBREL.

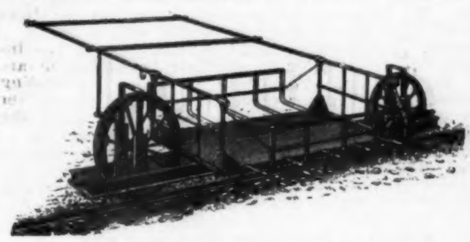


FIG. 16.—BASKET CAR.

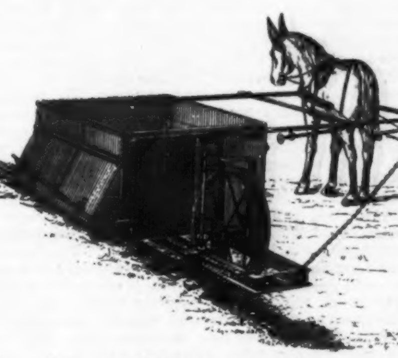


FIG. 17.—METALLIC BOX CAR.

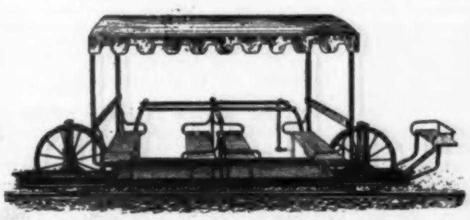


FIG. 18.—PASSENGER CAR.

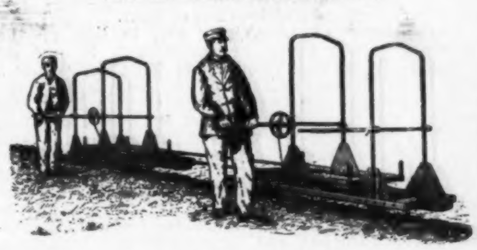


FIG. 19.—CAR FOR CARRYING RAILS.

Without entering into a detailed examination of the complex question of military transportation in the colonies, it will suffice to state that a line as easy to establish as the single rail one will give a singular suppleness to the forward movement of the column and a particular security for its daily provisioning, by furnishing it with an assured point of support and an uninterrupted connection with its base of operations upon the coast. From this view point, the single rail line, far from being a complication, will permit of a progressive and methodical advance of which the importance cannot escape the military world. This evidently favorable situation will necessarily have as a consequence a shortening of the campaign, a shortening of the sojourn of the troops in unhealthy countries and consequently a diminution in the number of the sick, and a termination of the operations in the fine season without risk of an interruption by rains, etc. From a financial and material point of view, the establishment of a single rail line will always economize a goodly portion of the duration of the campaign and often the necessity of a second one. For the above description and the illustrations we are indebted to La Revue Technique.

NOTES ON GAS ENRICHMENT.*

By Col. SADLER, J.P.

THE absorbing question of the hour—and indeed it has been for some time—is gas enrichment. The continuous cry from gas consumers for more light, and the never ceasing efforts of gas makers to produce still cheaper gas, compel the latter to tax every resource within their power to accomplish those widely divergent ends, viz., higher illuminating power without seriously increasing the cost. Cheaper coal and less gas taken off will do it, of course. But the first is not always available, and the second not often convenient. A larger yield of gas per ton of coal and the enrichment of its low illuminating power naturally suggests itself to every one as the readiest solution of the problem, especially in the district covered by this association, where coal is comparatively cheap.

Whatever value may be attached to oil or carbureted water gas in other districts, I cannot think that either one or the other will ever seriously come into competition with coal gas where there is an inexhaustible supply of good gas coal. The sudden and unexpected advance in the prices of mineral oils places carbureted water or oil gas out of the running at the present. Taking the value of carbureted water or oil gas at the minimum price of 1s. 2d. per 1,000 cubic feet, the present increased cost of the oil necessary amounts to 10d. more than before, making the gas cost 2s. per 1,000 feet. The long period of unprofitable returns in the oil trade makes it improbable that there will be an early return to the low prices lately prevailing.

The incandescent burner goes a long way in settling the vexed question of more light, independently of the candle power of the gas used; and there need be nothing more said about the matter had it not been discovered that rich gas is both better and more economical even with the mantle burners. I assume that good gas will be wanted, notwithstanding the general adoption of the incandescent light; and I want to show that benzol is the best and cheapest, as well as being the most natural, enricher of coal gas. It requires some courage to say this after the brilliant and classic researches of Prof. Lewes on acetylene, which shot athwart the sky of the gas world like a dazzling meteor, paling for the time all our poor attempts at illumination.

I have been asked to say a few words about acetylene. Well, it is a malodorous gas, which all here have often observed when ordinary gas is burned with insufficient air, as happens when a Bunsen burner is lit at the bottom, or has lit-back, as is often the case with cookers and gas stoves. It is a very poisonous gas, and, owing to its ready tendency to polymerize, i. e., form molecules of hydrocarbons, either multiples of itself or (by deposition of carbon and other rearrangements of its atoms) hydrocarbons of more complex structure, it explodes with the slightest detonation. A percussion cap (for instance), an electric spark, a blow, a point or nucleus of catalytic action are sufficient to provoke this unstable gas into dangerous action. Great caution will, therefore, be necessary with it should it ever become the auxiliary to illuminating gas that has been so sanguinely predicted for it.

Although acetylene has long been known, and many of its leading properties well understood, it remained to Prof. Lewes to show its marvelously high illuminating power, as well as many other striking characteristics noted at the same time by him, which were not observed before. No less astounding than the discovery of the luminosity of acetylene, to my mind, was the source from which Prof. Lewes proposes to supply it, viz., carbide of calcium made by fusing lime and coke in an electric furnace. Calcium carbide, when moistened with water, at once evolves acetylene and leaves a residue behind of slaked lime. Having got the calcium carbide, the production of gas is simplicity itself; and it is this simplicity that, in my opinion, constitutes one, if not the worst, of the dangers attending the use of acetylene. Conjure up in your minds what might happen at a gas works with tons of calcium carbide lying about!

The cost of acetylene gas depends on the price of calcium carbide. In all the calculations I have seen, it is assumed that the electric current required for converting the lime and coal or coke into calcium carbide will be obtained by water power, at a nominal cost, from some natural waterfall. Unless this is possible, and the electricity has to be obtained by steam power and the dynamo, the cost will probably be two or three times more than the figure that has been mentioned, which would place acetylene beyond the reach of purveyors of light at a reasonable price, notwithstanding its remarkably high luminosity. It is stated that the electric energy required to produce calcium carbide is capable of yielding four times more light in incandescent electric lamps than can be obtained in the form of acetylene gas from the calcium carbide. If this be so, where is the advantage of converting the electric current first into calcium carbide and then into acetylene, when it might be utilized vastly more economically by direct application? I am satisfied that, should calcium carbide ever be produced on a commercial scale, its cost will far exceed the estimates given; and, although it may not prevent its use as an illuminating agent, where expense is no object, it is unlikely to compete, or be available to mix, with coal gas.

I am not at all sure that acetylene cannot be made from benzol by what is known as "cracking," much cheaper than by the process just mentioned. I shall refer shortly to the relationship between acetylene and benzol.

There is no denying the extraordinary illuminating power of acetylene per se. But, owing probably to its endothermic character, when burnt (a property it appears to possess in a remarkable degree), it absorbs heat on decomposition, instead of evolving it, as is more generally the case with hydrocarbons. When mixed with ordinary coal gas, it does not yield that increase in light which its addition might lead us to expect. On the contrary, an enormous loss of light apparently takes place, probably from the absorption of heat by the combustion of acetylene and the consequent lowering of the temperature of the flame.

It is disappointing to find an illuminating agent so full of promise handicapped by so many objections and difficulties in the way of its application. I claim for benzol practically the same illuminating value as is possessed by acetylene; and, speaking from a chemical point of view, there is good reason for the assumption.

Acetylene consists of two atoms of carbon and two atoms of hydrogen; and benzol is constituted of three molecules of acetylene, six parts of carbon, and six parts of hydrogen. Benzol contains exactly the same percentage composition of carbon and hydrogen as does acetylene. Let me make myself clear. The formula for acetylene is carbon 2, hydrogen 2. The atomic weight of carbon is 12, of hydrogen 1. Multiplying them by two, we find the molecular weight of acetylene is 26, i. e., 24 of carbon and 2 of hydrogen. Now 100 parts of acetylene therefore contain in round numbers, carbon 92 parts, hydrogen 8 parts. The composition of benzol is: carbon, 6; hydrogen, 6. When calculated out in the same way, the molecular weight of benzol is 78, consisting of 72 of carbon and 6 of hydrogen. Therefore, 100 parts of benzol contain roundly: carbon, 92 parts; hydrogen, 8 parts, precisely the same as acetylene. If benzol is split up into three equal parts, each part would be C_2H_2, which is acetylene. The luminosity of flame depending, as it does, on the carbon in the gas, it is reasonable to expect that benzol, having the same percentage of carbon as acetylene, will give an equal illuminating power.

A good deal has been written and said about benzol as an enricher; and, although the subject is well worn, it is one of never failing interest. Allowing that it may be stale information to many of you, I venture to recapitulate briefly some of the statements lately made respecting it. Ordinary coal gas—say 15 to 16 candle quality—rarely contains more than 2 per cent. of benzol. It is to this comparatively small relative constituent that gas owes at least two-thirds of its lighting power. I cannot impress this fact too strongly upon you. Let me show you that this is the case. By passing this excellent Newcastle gas through a mixture of nitric and sulphuric acid, the benzol combines with the nitric acid, forming dinitro-benzol; and the gas is afterward seen to have lost most of its original illuminating power. In contrast I pass this same denuded gas over cold benzol; and the illuminating power is not only at once easily restored, but a flame of the brightest intensity appears.

Dr. Bunte, a German chemist, who has made gas enrichment a special study, declares that gas will carry 3 per cent. of benzol at the freezing point of water (32°

* From a recent presidential address before the North of England Gas Managers' Association, reported in the Journal of Gas Lighting.

F.) After eighteen months' continuous use, he asserts benzol to be the cheapest and best enricher of gas. He has devised an ingenious apparatus by which the feed of benzol into a small scrubbing column, up which the gas ascends, is regulated to the requirements of the gas, by displacement of the benzol from the store tank with water, a simple and handy contrivance, almost automatic in its working.

Dr. Schilling, in an interesting paper read before the German Gas Association recently, says his initial experiments with benzol for carbureting were so successful that it was definitely adopted at Munich more than twelve months ago; all the gas produced at the several works of that large city being benzolized during that period with the most satisfactory results, working smoothly, uniformly, and with gratifying success.

He gave some interesting and, I admit, astonishing figures, viz., that he could add 4 to 5 candles to the gas with 600 to 700 grammes (roughly 1½ lb.) of benzol, say one-sixth of a gallon; and that this was permanent at ordinary temperatures. After protracted refrigeration, at 32° F., an analysis of the gas showed it still held the benzol in diffusion. At 77° F., gas would hold four times as much benzol as at 30° F. He advocates enriching about one-twelfth and mixing with the rest. I disagree with this. The more gas passed through the benzolizer, the better.

I have drawn a rough sketch of the benzolizer, which is simple, costless and effective. You will observe that the gas passes over the cold surface of the benzol. The by pass arrangement can be adjusted to pass as much or as little gas through as may be desired, so that more or less candle power can be added at will, without any heating arrangement, if sufficient surface for evaporation is allowed for the benzol.

Schilling calls attention to the chilling benzol suffers by its rapid evaporation. He recommends slightly heating to 70° and 80° F., to counteract the refrigerating effect produced by vaporizing the benzol. This is unnecessary, except in very cold weather. He refers to the utility of benzol in the gas in preventing the deposition of naphthalene. Schilling also confirms in every particular Dr. Bunte's statements as to the value of benzol as a carbureter.

Mr. Charles Hunt, of Birmingham, who has had a long and wide experience in the manufacture of gas—whose opinion commands attention, and is, moreover, much respected by gas scientists—states that, having made crucial trials, one gallon of benzol enriches 9,500 cubic feet of gas one candle, while one gallon of petroleum spirit only raised 2,800 cubic feet. Dr. Dvorkovitz has made some exceedingly valuable communications on this subject; and, while naturally favoring his own oil gas process of enrichment, he confirms the Bunte, Schilling, Reis, and others' evidence re benzolizing gas. Mr. Lewis T. Wright, in a critical way, credits benzol with 40 candle power per cubic foot, that means 200 candles per 5 feet. The champions of acetylene claim not much more; and, if I am not much mistaken, there is no cause to complain, as it will be found that the luminosity of acetylene does not much exceed 200 candles, as a matter of fact. Mr. Forbes Carpenter, an authority, commenting on these results, does not dispute the German experts' figures. Professor Frankland, in his investigations on the property of benzol as an illuminating agent, finds that it is equal to 147 candles per cubic foot. Knublauch, an eminent German gas chemist, shows that, under the best conditions, benzol yields 184 candles.

It is difficult to reconcile such discrepancies, emanating as they do from such eminent men, and of undisputed authority on gas questions. It will at once occur to you, as it did to me, that the circumstances and conditions, the modes of testing the constitution of the gas treated, in each case must have been different. The perplexity arising from the conflicting statements I felt was evidently shared by others; for coincidentally with an effort to get at the truth of the matter, Mr. Walter King, of the Journal of Gas Lighting, suggested to me the desirability of ascertaining the actual intrinsic value of benzol as an illuminating agent, as had been done with acetylene. Difficulties at once presented themselves. The first one was that benzol is liquid at ordinary temperatures; and, in that form, I have so far been unable to burn it without producing a smoky flame. To compare its illuminating capacity with acetylene, I decided that it must be burnt under the same conditions so far as practicable. Now, as it requires a temperature over 212° F. to vaporize benzol, and to keep it in gaseous form (an essential preliminary to the trial), the elevation of temperature, of course, applies not only to the reservoir supply, but to the pipes to the burners too; and these pipes must also be steam jacketed. Then came the troublesome question of pressure; after that, the greatest of all obstacles, a suitable burner, which would completely, and with the best effect, flame the benzol gas.

I had hoped to have placed before you the results of my experiments to-day. They are, however, incomplete. Many interesting phenomena have cropped up in the course of my researches, which I shall not fail to communicate to you when the work I have undertaken is finished. I expect to show that benzol is little short of acetylene in illuminating value; and it will not surprise any one if I prove that it depolymerizes—or, shall I say splits up—into acetylene in the early stage of combustion. Also that the bond which holds the benzol molecule, C_6H_6, together is loosened, and three molecules of acetylene, C_2H_2, naturally fall asunder from it.

No president of any association could be more fortunate than I am in having friends who have vied with each other to make the office smooth and agreeable; and the hint of my desire to lay something before you respecting the merits of benzol as an enricher brought ready, clever, and reliable helpers with means at command prepared to make practical trials. Very valuable and varied information has accrued from these experiments, coming as it does from experienced, practical men. One of them reports exhaustively—taking pressure, temperature, and other affecting circumstances into account; and, after repeated and protracted trials, the details of which cover many sheets of foolscap, he states that the average result of simply passing the gas over cold benzol showed that 8,000 to 9,000 cubic feet of 17 candle gas were enriched 1 candle for each gallon of benzol consumed. A subsequent trial of a mixture of benzol and toluol (about half and half) was made at the same works, under precisely similar conditions—the mixture being absorbed cold. The results were not so favorable; and it was only found possible to raise the candle power in this way 1.58 candles—showing that, when toluol is used, a slight warming is desirable, as might be expected from its higher boiling point. The mixture of toluol with benzol did not raise the candle power of the gas in anything like the same proportion as the benzol itself; a gallon of the mixture only fortifying 6,000 cubic feet 1.58 candles. The constitution of toluol being C_7H_8, and therefore containing a less percentage of carbon, might account for some of the deficiency; but certainly not all. The reaction in the sphere of combustion—the flame—not yet perfectly understood, is responsible for the rest. At this rate, toluol appears to be more costly for enriching purposes than benzol. Forgive me for mentioning that toluol is methyl benzol—the methyl molecule (CH_3) displacing one of the hydrogen atoms of benzol, completely altering its character, and largely depriving it of its light-giving virtues. I suspect, on burning, this methyl molecule split off first, and containing three parts hydrogen to one of carbon, causes the mischief.

These results were confirmed at another large gas works, where a thorough trial of a mixture of benzol and toluol was made. At the latter works, careful and complete experiments on a considerable scale were undertaken with 90 per cent. benzol. Starting with a gas of 16.50 candle power at a temperature of 59° F., the illuminating power was raised to 21.94 candles, using 1,800 c.c. per 1,000 feet, or a gallon of 90 per cent. benzol enriched 13,800 cubic feet of gas one candle. Mr. Ferguson Bell succeeds in benzolizing about 20,000 cubic feet of gas one candle with a gallon of benzol. The Gaslight and Coke Company in London have for some time employed their production of benzol for enriching, in preference to selling it at current prices. My firm, for chemical purposes, extract the aromatic hydrocarbons from very large quantities of coal gas daily. After this treatment, the gas has no illuminating power, as is seen by the flame in front of me. May I ask you to again compare the same gas after it has been benzolized; showing the remarkable avidity with which the benzol is absorbed. We find that this quality of gas requires more benzol per candle to enrich than better gas to start with.

I have pretty conclusively proved that the difference which has been found in the enriching value of benzol arises from the fact that the trials have been made upon gas of varying constitution, and under different conditions. I have since found, too, that another important element enters into consideration in the matter, and may account for the conflict of opinion that we have among eminent savants. It is that in using a purer benzol we get an enormously increased illuminating power; so that those gentlemen who have got very high returns must have been using a purer benzol. The difference we found by using benzol of 95 or 96 per cent. purity, as compared with 90 per cent., was prodigious. Mr. Wright truly says: "Illuminating effect is not a fixed quality, unless all conditions are fixed. Change those conditions but slightly, and the luminosity will be greatly modified." The lower the gas is in illuminating power, the more costly it is to improve; and from my experience, it seems to work out in fairly exact ratio to the quality of the gas prior to treatment—i. e., to carburet 10 candle gas might cost 1¾d. each for the first two candles, then 1¼d. each for the next two candles, then 1d., and so on, up to a certain point, dependent on the gas treated, after which the cost increases pro rata with the candle power. At two of the large works mentioned, this feature was likewise corroborated. A good deal of the benzol appears to be absorbed in some inexplicable manner in the gas without a corresponding return in lighting effect, precisely as is the case (only in a greater degree) with acetylene.

In this week's Journal of Gas Lighting a table is given showing the illuminating value of acetylene admixed with gas. It confirms my statement. For instance, an admixture of 10 per cent. of acetylene to poor gas raises it only two candles. Now, as acetylene is said to possess 240 candle power, the addition should have resulted in a gas of 33 candle intensity. I dare say that a mixture of 10 per cent. of acetylene with a rich coal gas would give a more satisfactory result; but there would still be a serious loss of light.

The question of benzolizing gas, in lieu of the numerous other forms of enrichment, is one of considerable moment; and, apart from the points I have raised in favor of its adoption, there is the somewhat important one that the use of benzol for this purpose will take off the market the overproduction, which is depressing the value of tar, of which it is an important constituent, and further, that its addition to gas is natural, and objectionless, which cannot be said of other enrichers. Its application permits of a larger quantity of gas being taken from the coal, as it affords a simple and ready means of keeping up the illuminating power of the gas, and, for purposes of calculations, with average gas it will be pretty safe to assume that one gallon of benzol will enrich 12,000 to 15,000 cubic feet one candle, at a cost of ¾d. to 1d. per candle per 1,000 cubic feet.

ACETYLENE AND THE GAS INDUSTRY.

By NORTON H. HUMPHRYS, Asso. M. Inst. C.E., F.C.S.

THE discovery by Mr. L. T. Willson of a process for the commercial manufacture of acetylene, which turns out to be the subject of the paper read before the Society of Arts on January 16, is one that may well be calculated to raise a great deal of interest. It is a pity, however, it was not more clearly indicated by the title. Such a general expression as "The Commercial Synthesis of Illuminating Hydrocarbons" is deceptive, as not being likely to lead one who was not in the secret to expect a detailed account of some particular new process. "Sensation" is all very well in theatrical entertainments; but surprising situations are somewhat out of place in connection with commercial science. Had the real nature of the lecture been indicated, there would have been no necessity for making arrangements to secure an audience. But, after allowing for the personal eloquence and ability of Professor Lewes, it is evident that his subject possesses special fascinations that could not fail to attract and rouse the enthusiasm of his audience. Gas engineers, accustomed to deal with residuals such as coke, tar, and liquor, may well stand entranced before a complete gasification process leaving no residual, and calling for no second material as fuel or as enricher. This seems to be afforded by the process described. Given practically pure carbon and lime, the whole of the former is eventually obtained as a gas, while the latter simply acts as a carrier, and returns to its original form. The results approximate closely to theory; and there is no waste. The calcium carbide can be caused to yield its quota of gas by a beautifully simple and almost costless method, but little more troublesome than the trimming of an oil lamp. The fact that a single pound avoirdupois of this remarkable material can be made, by the aid of a few ounces of water, to furnish a brilliant light for ten hours, and at the same time leave a useful residual, is a triumph of modern science. It seems to me that it cannot fail to secure a future for the new compound, in the direction of compressed gas lighting for buoys, for railway carriages, and so forth. But the point which naturally first claims our attention is the value of this new process in relation to the supply of gas from central stations. In this connection, it offers several interesting considerations.

If the results quoted by Professor Lewes are supported by the further research which, I am glad to see, is promised, it will be necessary to modify, if not to entirely remodel, the existing theory as to the production of luminosity by the combustion of hydrocarbon gases. The "carbon density," the specific gravity of the hydrocarbons concerned, and the quantity of oxygen consumed, have all been said to affect the quantity of light yielded; while as to the temperature of the flame, the higher, the better. We have been told that an earthenware burner tip is better than a metallic one, because it does not conduct away so much heat from the base of the flame; and that the application of hot air in the regenerative burner increases the luminosity by raising the temperature, or, in order words, preventing the cooling of the flame. Any given quantity of carbon in the form of ethylene gives a much better lighting value than if it existed as methane; and this was explained by reference to the respective vapor densities.

But Professor Lewes shows us a gas having the same carbon density as ethylene, a lower specific gravity, a smaller oxygen consumption, possibly a lower flame temperature, than any of the luminous hydrocarbons (with the exception of methane); and he claims for it a very high illuminating value—placing it, in fact, at the head of the gaseous illuminants. It will be interesting to extend the table of comparative illuminating values quoted by him (ante, p. 169), so as to show the properties of the respective gases. An examination of this, according to the light of acknowledged theory, fails to indicate any reason why acetylene should be so far superior to the others.

	Photometrical value.	Percentage of carbon.	Volumes of oxygen required by one volume.	Specific gravity.	Proportion of hydrogen equivalent to carbon equivalent.
	(1)	(2)	(3)	(4)	(5)
Methane (CH_4)	5·2	75·0	2·0	0·553	4·0
Ethane (C_2H_6)	35·7	80·0	3·5	1·037	3·0
Propane (C_3H_8)	56·7	81·8	5·0	1·522	2·66
Ethylene (C_2H_4)	70·0	85·7	3·0	0·968	2·0
Butylene (C_4H_8)	123·0	85·7	6·0	1·936	2·0
Acetylene (C_2H_2)	240·0	92·3	2·5	0·910	1·0

Comparing the specific gravities, it will be seen that equal weights of ethane and propane and of ethylene and butylene respectively yield something approaching equal photometrical values. The futility of placing any faith in carbon density is shown by comparing ethane, ethylene, and acetylene, all of which are equal in this respect. Columns 2 and 5 show a gradually increasing proportion of carbon, and a gradual diminution in the proportion between the hydrogen and carbon equivalents.

But it should be remarked that acetylene has been tested under specially favorable conditions as compared with the other hydrocarbons. Referring again to the table on p. 169, it will be found that the first four items (which, by the way, are reproduced from my work on "The Chemistry of Illuminating Gas," p. 91) refer to experiments conducted several years ago, at a time when our knowledge as to the best way of burning rich gases was very meager. Such gases had never been used in practice; the regenerative and incandescent systems of combustion were in their infancy; and Sugg's "London" Argand burner was the "king of the castle" in regard to all questions of illuminating value. But since that period great strides have been made. The advancement of oil gas, compressed and otherwise, has led to the manufacture of special burners; so that it is now as easy to suit 80 or 90 candle gas as 16 or 20 candle gas with the appropriate means of consuming it. The value of ethylene, for example, was ascertained by burning it in an ordinary standard Argand. If these gases were placed on the same footing as acetylene, and consumed in small flat-flame burners, there is every reason to believe that the results would be higher, and therefore that the advantage claimed for acetylene would not be so great.

The photometrical value of these rich gases, however, is not so important as the enriching value; and the evidence on this point is somewhat unfortunate for acetylene. It is admitted to be of no use as an enricher of water gas, which shows that either carbonic oxide or hydrogen is not a suitable diluent, or perhaps both. When applied in such small proportions as are likely to be used in actual practice, the enriching value appears to be much less than the photometrical value. With other gases, the enrichment value is found to be greater. Dr. Percy Frankland obtained an enrichment value for ethylene of some 20 per cent. more than the ascertained photometrical value; and some of the oil gases have been claimed to show a gain of 50 per cent. in this respect. This matter has usually been explained by the assumption that the burner used for consuming the gas in the pure form was not capable of doing full justice to the photometrical value of the gas.

Some further information as to the effect of diluents

upon acetylene is furnished by Professor Lewes, who asserts that "all the hydrocarbons in a luminous flame are converted into acetylene before any luminosity is produced;" and farther on he gives the production of carbonic acid from London gas as one-fourth of that which would be evolved by the combustion of a similar bulk of acetylene. From this it appears that the London gas should yield something more than one-fifth of its bulk of acetylene, after a liberal allowance for carbonic oxide. So that the acetylene formed by the combustion of London gas, if it could be separated and used "neat," would be sufficient to yield a light of 48 candles, or threefold that actually afforded by the gas. This at once suggests the question whether acetylene is concerned in any way in the improved results afforded be regenerative and incandescent burners, which have always appeared to me to be very remarkable. The general idea of "improvement" runs in the direction of 10 or 20 per cent. When the available duty increases from threefold to fivefold, an entire change of conditions is implied.—Journal of Gas Lighting.

THE PRODUCTION AND USES OF COTTONSEED OIL.

By P. L. SIMMONDS, F.L.S.

I THINK I may claim the merit of having first suggested the production of cottonseed oil. Forty years ago, in a course of lectures I gave before the Society of Arts and Manufactures, in London, on "The Utilization of Waste Products," I mentioned, among other waste products, cottonseed, which was then an incubus cotton cultivators did not know how to get rid of.

The council of the Society of Arts awarded me their silver medal for my valuable suggestions, and subsequently elected me a life member, under one of their rules, in consideration of being eminent in the application of abstract science to the arts, manufactures and commerce.

These lectures I afterward expanded into a volume, under the title of "Waste Products and Undeveloped Substances," which went through several editions and is now out of print. I have reason to believe that the adoption of many of my suggestions has resulted in fortunes to some, and has utilized profitably much of the former waste in manufactures.

The Science and Art Department employed me to form a collection of waste products and their utilization, with a descriptive catalogue, which is now placed in the Bethnal Green Museum.

I had also to make a similar collection for the Austrian government at the Universal Exhibition held in Vienna in 1873.

To return to cottonseed oil. At the time my suggestion was made of utilizing cottonseed for oil in 1855, the United States production was less than 1,250,000,000 pounds; now the production has risen to about 3,500,000,000 pounds. The first shipment of cottonseed oil in the year ending June, 1872, was but 547,165 gallons, and few would have anticipated it would reach, in 1892, the enormous export of nearly 14,000,000 gallons, worth nearly $14,000,000. The various forms of cottonseed all yield good oils capable of being refined for dietetic use.

The oil possesses excellent lubricating qualities, and is useful for soap making and for lamps. The quantity of oil produced, even in England, is large, the imports of cottonseed exceeding, in some years, 400,000 tons.

In the States the production of seed exceeds 3,000,000 to 4,000,000 tons, of which half is available for oil; 100 pounds of seed will yield two gallons of oil. There are four qualities of oil made. The crude oil is of a dirty yellow to reddish color; on standing it deposits a slimy sediment. The second quality has a pale orange color, and is obtained by refining the crude oil with a solution of caustic soda. The yellow oil resulting from this process is further purified by being heated and allowed to settle again, or by filtration, and is called "yellow summer oil." "Winter yellow oil" is made from the above material by chilling it, until it partially crystallizes, and separating the stearin (about 25 per cent.) in presses, similar to those used for lard.

This is then treated with fuller's earth in a tank, which holds back the coloring matter, and the oil which issues from the filter press is almost white.

In 1893 there were probably 1,250,000 tons of cottonseed crushed in the United States. From this seed there were obtained 1,000,000 barrels of oil. It is estimated that 300,000 barrels were used in Chicago for making oil lard; and St. Louis, Kansas City and Omaha took 200,000 for the same purpose. About 250,000 barrels went to Holland for making margarine, and large quantities to Southern Europe for mixing with olive oil.

Cottonseed oil appears to be useful for table purposes, and it is desirable that its use in the pure state, rather than as a mixture, should be encouraged. It ought, however, to be sold on its merits, and with the addition of some qualifying term, which will indicate its origin.

This oil has entirely replaced olive oil in America, and there is scarcely a restaurant in London or Paris in which this new "salad oil" has not taken the place of the old Lucca product. In Portugal every means are now taken to prevent the sophistication of olive oil with cottonseed oil, or passing it off as a food oil of the same value as olive oil.

For pharmaceutical purposes cottonseed oil cannot be regarded as a good substitute for olive oil. It saponifies with difficulty as a drying oil, and the coloration which it gives with nitric acid shows that if used for any preparation liable to oxidation it may give curious results. The density of crude cottonseed oil is 0·920 to 0·933 and when refined 0·925 to 0·930.

To distinguish cottonseed oil from olive oil, take pure, colorless nitric acid of density of 1·40 and mix it with half the quantity of oil in a test tube closed with gum. After shaking it for several seconds, allow the tube to rest in a vertical position for five or six minutes. If the oil is from olives, the liquid is at first pale or colorless, changing to an ashy gray, with a slight yellowish hue. On shaking, a coffee-brown color will be seen if cottonseed oil is present. The reaction is delicate enough to detect an adulteration of 5 per cent. of cottonseed oil.

The shipments of cottonseed oil from the United States have progressed as follows in decennial periods:

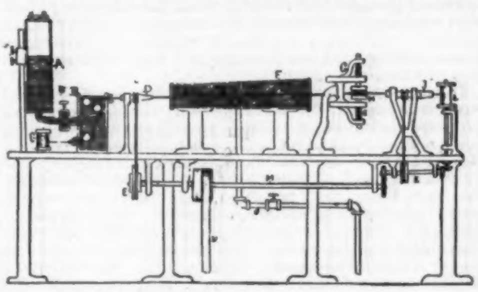
	Gallons.
1873	709,576
1883	415,611
1893	9,462,074

With the extended production of cotton in various countries—India, China, Egypt, Brazil and the United States—a great future awaits cottonseed oil. Some idea of the magnitude of the future may be formed from the fact that British India produced in 1889 a little over 9,000,000 cwt. of cleaned cotton; that amount must have been obtained from 27,000,000 cwt. of seed. Allowing half this to be required for home consumption and seed for next crop, over 6,000,000 cwt. of seed should have been available for export, whereas, the export of seed has hitherto seldom reached 37,000 cwt. This year the export of seed will be larger, as for the nine months already expired, nearly 89,000 cwt. has been shipped. The weight of seed may be estimated at three pounds for every pound of cleaned cotton.—Am. Jour. Phar.

COTTON FROM WOOD PULP.

A COMPANY has been formed at Providence, R. I., the object of which will be to promote the application of wood pulp to textile and other uses, and this concern has a mode for making pulp cloth under consideration; so have a number of others. In some instances the fabric resembles white duck very closely in its general character. One of the most successful processes has been developed this winter and is described in this article.

In this improved method for obtaining artificial cotton, or a textile thread which shall closely resemble the product used in manufacturing white duck trousers, the first operation consists in the selection of the stock. Whitewood is preferable, and this is chipped, digested and otherwise prepared, and the pulp is given a bath in a liquid composed of methyl, alcohol and sodium. After standing overnight the processes of treating the threads are undertaken and accomplished by the use of a machine built on the lines exhibited in the model shown in the drawing, of which this is only a single section, showing one thread in process of treatment. A glass tank will be noticed at A, in which a liquid composed chiefly of a nitro-cellulose solution combined with a mineral acid is put. In the other tank, marked B, a solidifying liquid made of turpentine, petroleum and wax is put, and the arrangement of pipes and connections is such that the contents of the upper tank slowly and gradually work their way down into the lower during the treating operation.



COTTON FROM WOOD PULP.

Only one filament is shown in the cut, and this is presented at C as wound on a spool. The process of getting the pulp into a thread-like form is conducted on the regular lines now pretty well known to pulp manufacturers, the principal point in this instance being the mode of treating the thread in a manner which will change its character from a paper or wood yarn to a superior cotton.

The actual treatment of the thread begins when it enters the aperture in the tank, B, as indicated. A thorough saturation is effected by having the thread wind about the rollers in the interior, after which the thread passes out at the top and into the revolving tube, D, the rapid revolutions of which cause the strand to twist many times, thus solidifying the emulsion within the turns. The tube is given motion from the pulley, E, the latter being turned by the main shaft, M, and this by the belt, N. Next the thread passes into the drying chest, F, the interior of which is seen, and the series of drying pipes can be observed, these being furnished with steam through the pipe, O.

The pipes are perfectly smooth, and the strand contracts with them sufficiently to receive a slight polish, thus adding brilliancy at a stage when it becomes most perceptible, for the nature of the ingredients received just previously is such that the least friction imparts immediate and lasting polish. Next the thread passes through a silky brush arrangement at G, in which H marks the brushes, and I the spring which gives elasticity to the affair, so that the brushes rise and depress as necessary. The silk brushes give luster to the passing strand, and also wipe off foreign substances. Once more the thread is rapidly revolved while going through the tube, J, this latter receiving its revolutions from the pulley, K, after which the strand is wound upon the spool, K.

Several processes for producing textiles from paper have been noticed during the past year or so, but most of these fail to produce a substance which will stand washing. White trousers need regular cleansing, therefore the stock of which they are woven must be right. The solidifying emulsion employed in the peculiar manner above related makes the threads waterproof, as it coats the fiber. The process is comparatively cheap; the threads are white and semi-transparent; they weave readily.—George Damon Rice, in the Paper Trade Journal.

INFLUENCE OF TEMPERATURE ON THE SENSIBILITY OF PHOTO PLATES.

THE most important of the new researches brought under the notice of the recent Camera Club Conference were by the president of the club, Captain Abney, who has just been conducting some experiments on the influence of temperature at the time of exposure, at such a range of the thermometer as photographers are likely to meet in different parts of the world. The subject is not entirely a new one with him, because in 1884 he published a few experiments in the Bulletin of the Belgian Photographic Association, in which he showed that when the back of a photographic plate was warmed with a hot flat iron, and exposed before it became cold, gelatine bromide films would bear a shorter exposure. With collodio-bromide dry plates, the reverse was the case, but that was found to be due to the removal of hygroscopic moisture; when they were kept sufficiently damp, their rapidity also was increased by elevation of temperature.

In his experiments just published, he took two boxes, one inside the other, the smaller one screwed to the top of the larger one, and the space between filled with powdered ice and salt, to produce low temperatures, and for warm temperatures he put a hot brick inside between the boxes, instead of the ice and salt. The plate under examination was placed face upward on the bottom of the smaller box, and light was admitted to it, when desired, through a hole in the top piercing the two boxes; the light was reflected from a horizontal beam downward through the hole by a mirror placed at an angle of forty-five degrees. With this arrangement he could obtain temperatures ranging from − 18 deg. C. to + 33 deg. C., such as may be obtained in actual work in some places abroad; he could also obtain any intermediate temperatures desired. One peculiar point he discovered was, that somewhere between the temperatures of + 33 deg. C. and + 38 deg. C. the curves of sensitiveness of gelatine bromide plates lose their character, probably because of the escape of a certain proportion of hygroscopic moisture. Captain Abney found that with a slow lantern plate, the exposure had to be doubled on lowering the temperature from that of a hot summer's day to zero, but that with a very rapid plate the difference in the necessary exposures between − 16 deg. C. and + 33 deg. C. was less marked, and with Fitch's celluloid films the difference in rapidity between the two temperatures was less still. With collodio-bromide plates, the difference in rapidity between − 17 deg. C. and + 32 deg. C. was marvelous; at the higher temperature it increased four or five times. Different makes of plates vary in their changes in rapidity at different temperatures, and perhaps the expansion or contraction of the film has something to do with it. His exposures in these experiments varied from 5 to 320 seconds, and his conclusion is that variations in the rapidity of plates, with changes of temperature, form a factor which should be taken into consideration by practical photographers. The temperature, within the limits stated, does not alter the gradation of the negatives.

ANOTHER PRODUCT OF ESCAPED ELECTRICITY.

As bearing upon the question of the formation of unexpected chemical compounds in street culverts, etc., by escaping electricity, Mr. Arthur Wright, the engineer and manager of the Brighton Corporation Electricity Works, writes to the London Electrician to describe a mysterious circumstance that occurred in that town last October, when it was discovered that "shocks" could be obtained from the casing of the electric lighting service in a certain house. Inspection revealed the fact that the casing in question was covered with "a furring similar to that noticed on new buildings;" and on removing the cover, a serious leak was discovered, from a badly made joint to a nail in an old wall. There were no evidences of charring. The whole of the casing was saturated with moisture; and there was a hole in it with edges of a light brown furry nature. On the surface of the capping that had been in contact with this faulty joint, there was a large accumulation of a white pasty deposit, yielding sparks freely upon rubbing with the finger, even after removal. Mr. Wright testifies to the fact that for several days after the piece of capping had been brought to the works for examination, brilliant but minute flashes of light could be obtained from its under surface by drawing the finger over it. The trouble that might have ensued by the combination of escaped gas with this unnamed product of escaped electricity, of course, need not here be dilated upon.

INDUCED MAGNETISM IN VOLCANIC ROCKS.

AN interesting note by G. Folgheraiter, on the magnetism induced in volcanic rocks by the earth's magnetic field, appears in the Atti della Reale Accademia dei Lincei (vol. iv, part 5, March 3, 1895). The author has performed a number of experiments on volcanic rocks, in order to determine the amount of induced magnetism left when, after heating to such a temperature that they entirely lose their permanent magnetism, they are either allowed to cool slowly or are suddenly cooled, in each case under the influence of the earth's field. From such observations he hopes to be able to deduce some conclusions as to the conditions under which the rocks experimented on, which were originally permanently magnetized, became magnetized. The rocks are cut into small parallelopipedons weighing about 50 grammes, and such that the length is about two or three times the depth or breadth, care being always taken to cut the rock so that the axes of these pieces were vertical when the rock was in its place in the earth. The intensity of magnetization was in every case measured by the method of deflection; a freely suspended magnetic needle being deflected by the sample, which was placed with its length east and west. After measuring the intensity of magnetization of the samples, they were heated to redness, and then either allowed to cool slowly or are rapidly quenched with their axes vertical. Their magnetic moment was determined, first immediately they were cool and then after they had stood under the influence of the earth's field for three months. The specimens of basalt examined may be divided into two groups: in the first may be placed those specimens which were originally only slightly magnetized, and in this case, after heating to redness, the magnetization is always increased, but to a very different degree in the different specimens. The second group includes those basalts

which were originally strongly magnetized, and in this case after heating the magnetization was considerably reduced. In both groups the magnetization underwent no change during three months, and sudden cooling gave the same results as slow cooling. Experiments have also been made on tuff and peperino. The results obtained with the first of these rocks are similar to those obtained with the first group of basalts. Peperino, however, differs in that, before being heated, its coercive force seems almost nil, the bar becoming only temporarily magnetized. After heating, the character of the rock is altered, as it can now become permanently magnetized and behaves just like the tuff. From this the author concludes that peperino has been formed at a low temperature, probably by the action of water on cinders, etc.

RECENT ADVANCES IN ELECTRO-CHEMISTRY.*

By JOSEPH W. RICHARDS, A.C., Ph.D.

THE lecturer was introduced by the secretary of the institute, and spoke as follows:

MEMBERS OF THE INSTITUTE, LADIES AND GENTLEMEN:

Electrochemistry is that division of chemical science which treats of the mutual relations of the electrical and chemical forces; it discusses the electrical effects of chemical action and the chemical effects of electrical action. This field has received a due share of attention in the century which has elapsed since it was opened to cultivation, but it is only within very recent years that its immense expansion, in both applied and theoretical aspects, has lifted it into the position of a distinct science.

To be qualified as an electrochemist, the scientist must, first of all, be a chemist, knowing all that is implied by that term; and in addition to this, he must also be well informed in applied and theoretical electricity. But men thus qualified are few in number. Chemists generally have a smattering of electricity; electricians, as a class, know less about chemistry, so that the scientist who is master in both sciences may be termed a rara avis. Nearly all electrochemical processes can be carried on only by the practical chemist, while the electrician plays a subordinate role.

The rapidly growing importance of the applications of electrochemistry has created a need for educated electrochemists with the above-described qualifications. The universities are looked to as able, if they will, to supply the want; and, in response, we note the establishment, within the last few years, of separate departments of electrochemistry, with a professor at the head devoting all his attention to that subject. At Leipzig, Dr. Ostwald; at Gottingen, Dr. Nernst; at Aachen, Dr. Classen; at Hanover, Dr. Kohlrausch; in Berlin, Prof. Slaby and Dr. Vogel; in Munich, Prof. W. von Miller; in Darmstadt, Prof. Kittler; in Amsterdam, Prof. van 't Hoff; in Munster, Prof. Hittorf; in Paris, Moissan. In the United States, Johns Hopkins University has under consideration the establishment of a chair of electrochemistry, and will probably take the lead in this direction, as it has done in so many other useful innovations; and it is to be hoped that in the present brilliant plans for the extension of post-graduate study at the University of Pennsylvania this promising field will not be overlooked.

In Germany, interest in electrochemistry has become so general that the German Electrochemical Society (Deutsche Elektrochemische Gesellschaft) was organized in 1894. Sixty-five scientists signed the call for a meeting, which was held in Cassel on the 21st of April, when the society was duly organized. Dr. Ostwald was chosen first president, and what promises to become a most flourishing society was started with great enthusiasm. The first yearly meeting was held in Berlin, on October 5 and 6, 1894. Bunsen, Kohlrausch, Hittorf and Wiedemann, the lights of electrochemical science in Germany, were named honorary members. Ostwald delivered an able address on "Johann Wilhelm Ritter, the Founder of Electrochemistry," and a number of other important papers were read and discussed. At the close of 1894, the society already numbered 290 members, among whom were enrolled about a score of interested participants from this side of the ocean.

Within the past year there has also been founded at least one journal devoted exclusively to this new science, and three others which devote particular attention to it. The Elektrochemische Zeitschrift, a monthly journal, made its first appearance in April, 1894. It is published in Berlin, and has the co-operation of most of the prominent electrochemists in Europe.

About the middle of the same month, the Zeitschrift fur Elektrotechnik und Elektrochemie made its first appearance in Halle, and is now published semi-monthly. This journal, as its name indicates, gives equal attention also to electrotechnics in general. It has been chosen as the official organ of the German Electrochemical Society. The Aluminum World, published monthly in New York, since September, 1894, devotes special attention to electrometallurgy, one of the most important branches of electrochemistry. L'Aluminium: Journal de l'Electrolyse, is a journal of similar range, published monthly in Paris, and which has made its first appearance within a month (January 3). With such exceptionally favorable facilities for spreading information in the German, French and English languages, not to speak of a host of other journals of chemistry, metallurgy and electricity, eager to reprint each item of value, every advance in electrochemistry is sure of being at once made known to the industrial and scientific world.

If inquiry be made as to any recently published standard books on electrochemistry, it must be said that there is none which covers the whole ground. Ostwald's "Elektrochemie—Ihre Geschichte und Lehre" is in course of publication, but it treats of the purely scientific side of the subject. Dr. Gore's "Electric Separation of Metals" is the best work in English on electrometallurgy; while Dr. Borchers' "Elektrometallurgie" gives a still more recent review of that part of the field, in German. In French, Tomassi's unwieldy volume, "D'Electrochimie," is a compilation of much valuable information thrown together in a rather disjointed way, but the reader will find recorded in it many out-of-the-way facts which have escaped the other writers. Yet many of the subjects which will be spoken of to-night are of so recent development that they have not yet found their way into the books, and allusion to them can be found only in the journals above mentioned.

As the limits of a single lecture will only allow of a brief allusion to many interesting subjects, I give in each case references to the journals, which any one interested may consult for further information.

Electrochemical Analysis.—Classen* has made a noteworthy contribution to this elegant method of analysis, by an exhaustive review of all his methods, giving in each case the concentration of bath, voltage, current density, temperature, etc., for best working. Such data were long needed, and this very thorough memoir marks an epoch in the history of electrochemical analysis.

Batteries.—An entire evening would be necessary to describe all the newly invented batteries. One, however, deserves special mention, because of its applicability to electrochemical experiments requiring high voltage. Warren† describes a cell consisting of magnesium in a solution of ammonium chloride and copper in a solution of cupric chloride and hydrochloric acid. It is claimed for this cell that its electromotive force is three volts, and that, because of its small internal resistance, it furnishes a current of great quantity. A single large cell, it is said, will run a sewing machine. Warren claims that it gives a strong, constant current for a long time, and is certainly the most powerful cell known.

Theory of Electrolysis.—Ostwald and the investigators identified with the new school of physical chemistry have industriously worked upon this subject. The theory of free ions in a solution has been elaborated. By this theory it is assumed that when a salt, such as potassium chloride, is dissolved in a large amount of water, part of the salt molecules are dissociated into free potassium and chlorine atoms (ions), and that the current has a directive tendency only on these free ions. Salts which do not thus dissociate give solutions which do not conduct electricity; therefore all electrolytes are composed of the salts which do dissociate. Further, all electrolysis of aqueous solutions is held to be primary; secondary reactions are regarded as an unnecessary complication of the explanation; the water is always primarily decomposed. Thus, a solution of potassium sulphate is supposed to contain, as free ions, hydrogen and potassium atoms and hydroxyl (OH) and sulphuryl (SO_4) groups. At the negative electrode, hydrogen is separated, and the hydroxyl groups left behind form potassium hydrate with the potassium ions in the solution; on the other electrode, hydroxyl separates, while the hydrogen atoms left behind form sulphuric acid with the sulphuryl ions in the solution.

The above explanation, I beg to observe, is a literal translation of Dr. Le Blanc's own words, and shows us how completely these theorists are begging the question. Your lecturer coincides entirely with the committee of the British Association for the Advancement of Science, that, while many remarkable facts have been recorded, and ingenious experiments made, by the German school, their explanations and theories are insufficient, misleading and not warranted by the facts. The electrolytic dissociation theory is fundamentally opposed to the doctrine of the conservation of energy, and the attempts of the upholders of the theory to answer this objection satisfactorily have been altogether futile; indeed some of their so-called explanations are unworthy of serious attention.

O. Wiedeburg‡ has recently proved, by very careful experiments, that when the electromotive force at the electrodes is less than the voltage calculated as necessary for decomposition, a very small current passes through the solution, which increases slowly as the voltage increases, and rises very suddenly when the calculated voltage is reached. But the curve showing the quantity of current passing is not vertical at any point, although very steep in the neighborhood of the calculated decomposing point. This would show that in the solution some molecules of the salt are bound together with a force less than the average for all the molecules, while others are bound together more strongly. It is only a confirmation of the Clausian theory of molecular motion, and in no sense proves the electrolytic dissociation hypothesis.

The reports of the Electrolysis Committee of the British Association for the Advancement of Science will be found to contain much healthy criticism of these new electrolytic theories.

Electricity Directly from Carbon.—E. E. Brooks§ discusses what has been done in this direction. He dismisses thermo-couples with a very few words, as having too low an efficiency ever to be economical on a large scale. The only promising forms are cells using carbon as the negative plate. Niter is unsuitable as an exciting liquid, because it acts too violently and too much is consumed for economy. The greatest stumbling block, however, is the material for the positive plate. Platinum is too costly and other metals oxidize too easily. Brown found that inserting a carbon rod in a Hessian crucible placed in a fire and another carbon rod in the fire outside the crucible, a difference of potential of 0·2 volt was noticed between the two carbons. On putting niter into the crucible, the voltage rose to 0·4, the crucible acting as a porous cell. Under similar circumstances, with melted potassium bisulphate in the crucible, voltage as high as 1·57 was obtained, and a current strong enough to run a bell. If a few drops of concentrated sulphuric acid were added from time to time, the current could be kept up as long as desired. Brooks concludes that in this case potassium pyrosulphate is the electrolyte.

Ostwald records this experiment: Two vessels containing water are connected by an inverted U-tube. In one is placed a platinum electrode and in the other a zinc electrode, and these are connected by a wire running through a galvanometer. On adding some sulphuric acid to the water surrounding the zinc, brisk chemical action begins, but there is no current in the wire. On the other hand, if the acid be added to the water surrounding the platinum, gas is liberally evolved at the platinum electrode and a strong current is set up in the wire. From this experiment, Ostwald argues that in order to get the full effect of the chemical action converted into electricity, in Jablochkoff's cell (iron and carbon in fused niter), the oxidizing material should be around the iron only, and not in contact with the carbon.

In the future carbon cell, the oxidizing material will not be around the carbon, but around the non-oxidizing electrode. A cell properly constructed on these principles could burn carbon like an ordinary stove, but what is wanted before we can construct it is a suitable electrolyte, which will act merely as a medium or conveyor of the oxygen, and which will not be consumed. The solution of this problem does not appear impossible.

Borchers* attacks the question from another direction. He argues thus: "It is practically impossible to oxidize carbon satisfactorily in a cell and obtain its energy of oxidation as electricity. The gasification of the coal to carbonic oxide and the subsequent oxidation of this combustible gas in the cold is the first rational step toward obtaining the electric current." Borchers, therefore, directs his investigations toward a cell in which carbonic oxide is dissolved in a menstruum, and in that condition is oxidized. A solution of cuprous chloride dissolves oxygen, carbonic oxide and hydrocarbon gases. A cell is therefore constructed containing this solution, dipping into which are two copper tubes serving as + poles, and through which carbonic oxide is forced into the solution. Between these is an inverted carbon bell, into which is pumped air, and which serves as the — pole. An electromotive force as high as 0·4 volt is obtained, whereas the oxidation of carbonic oxide should give 1·47 volts. A very feeble current, however, is obtained from a large cell. The correct theory of the chemical actions occurring is not beyond doubt, and the cell is at present very far from being successful in an economic sense.

This gas element has attracted wide attention. Already, L. S. Powell† has suggested an improvement. The carbon electrode is heated red hot in the air for a short time, giving it a mossy coating, which absorbs oxygen more readily, and makes its action as a porous cell much stronger.

Ozone.—Dr. Frohlich‡ reviews the production and utilization of ozone. Siemens and Halske produce it cheaply in large quantity by passing through air the silent discharge of a very high potential alternating current. Two metal tubes are taken, one placed inside the other, insulated from each other by strips of mica, and air is passed between them while the discharge passes from one tube to the other. Or, two thin glass tubes are placed within a third. Inside the inner one is water; between it and the next is the air space, and between the second and third again is water. The two water poles are made the terminals of the current. The ozone thus made is used for disinfection, bleaching wax, oils and sugars, restoring the taste to alcoholic liquors, purifying tobacco and coffee, and for making nitric acid. It is stated that a method has been discovered, and which will soon be published, whereby nitric acid can be made directly from moist air in the ozone tube.

Purification of Drinking Water.—G. Oppermann§ affirms that "since all natural water contains small quantities of different salts, these can be resolved into their constituents by the electric current, and, under certain conditions, form ozone and hydrogen peroxide, which purify the water by destroying the organic impurities and lower organisms. It is now established that, under proper conditions, water can be completely sterilized by the electric current. The organic impurities can be so completely removed that treatment in the chemical way will show no trace of organic matter, and bacteriological tests by gelatine cultures will show no trace of micro-organisms." Oppermann first passes the current through with platinized electrodes. The ozone and hydrogen peroxide left in the water give it an unpleasant taste, to remove which the water is again electrolyzed with aluminum electrodes. Precipitated hydrous alumina is formed, which completely clears the water, the glue-like material enveloping the finest suspended particles, entangling and carrying them down with it. In this operation, a current of low voltage and large quantity is used. The precipitate is filtered out, calcined and sold as alumina.

Dr. Lugo simplifies the matter by electrolyzing only with aluminum electrodes. This causes a greater consumption of aluminum, but not enough to interfere with the practicability of the process, and the work is done in one operation. The apparatus consists of a trough in which are placed alternately zinc and aluminum electrodes, the latter being the anodes. Water flows continuously through the trough, underneath each aluminum plate and over each zinc plate, passing out at the other end. It is then filtered to remove the alumina. The apparatus can be constructed on any desired scale, and it is reported that plans have been drawn for a plant to purify Passaic River water for the supply of Jersey City, to the extent of 30,000,000 gallons daily.

Purification of Salt-spring Brine.—The usual impurities are bicarbonates of iron, calcium and magnesium, calcium chloride and sulphate and magnesium sulphate. Collins‖ passes through it a current of 2·5 volts, which does not affect the common salt, but renders the impurities insoluble. Calcium bicarbonate, for instance, splits up into calcium hydrate (precipitated) and carbonic acid gas, while the latter precipitates more of the bicarbonate as carbonate; the reactions are

$$CaH_2(CO_3)_2 = Ca(OH)_2 + 2CO_2$$
$$CaH_2(CO_3)_2 + CO_2 = CaCO_3 + H_2O + 2CO_2$$

Disinfection of Sewage.—Hermite's process of electro-

* A lecture delivered before the Franklin Institute, February 1, 1895.—From the Journal of the Institute.

* Berichte der Deutsch. Chem. Gesellsch. 1894, 2,060. Elektrochemische Zeitschrift, November, 1894, 144.

† Chemical News, 70, 179.

‡ Zeitschrift fur Physikalische Chemie, 14, 174.

§ Elektrochemische Zeitschrift, 1894, 124.

* Report of the first yearly meeting of the German Electro-Chemical Society, October 6, 1894.

† Electrical Review, December 7, 1894.

‡ German Electro-Chemical Society, first meeting, October, 1894.

§ Elektrochemische Zeitschrift, September, 1894. The Aluminum World, March, 1895.

‖ Wagner's Jahresbericht, 1892, 326.

lyzing sea water with the formation of magnesium hypochlorite, and running this into the sewage, has been subjected to a thorough test at Worthing, England. The medical officer of the local health board says, in his report, that there is no instantaneous decomposition of fecal matter, and no complete sterilization of the sewage, and recommends, as an improvement, the passing of the electric current directly through the sewage itself, 2·5 to 3 volts being sufficient to kill all ordinary bacilli.

At Brewsters, New York, the Hermite process has been adopted, however, with great satisfaction.* A current of 700 amperes and five volts is sent through sea water as it flows slowly between four carbon cathodes (each one foot square) and three platinized copper anodes. The rate of flow is so regulated that the solution is electrolyzed to the proper degree, and then is caused to overflow directly into the sewer. The disinfection is practically complete. Comparative tests show that the solution equals in effective strength a one per cent. solution of chloride of lime, which latter would cost 1·4 cents ger gallon, while the electrolyzed sea water costs only 0·01 cent.

The process is thus proved to be satisfactory for treating ordinary dilute sewage, but the English tests show that it does not completely sterilize concentrated sewage.

Bleaching.†—Hermite's process consists in decomposing a solution of magnesium chloride, the resulting hypochlorite being allowed to act, either directly on the substance to be bleached, and which is placed in the electrolyzer, or by being drawn off, and the bleaching done in a separate tank. The process is in general use abroad, and, to a limited extent, also in the United States. Animal fibers cannot be subjected to this mode of bleaching; it is most usually applied to cotton, linen, hemp, jute and paper pulp. In treating wood pulp, it is subjected to the action of a hot solution of common salt, under pressure, while the electric current is simultaneously passed through. This is effected in a strong digester, patented by Kellner. Electrolytic bleaching costs about one-half as much as the old method with chloride of lime. The electric current which lights the works at night can be run during the day through the electrolyzers.

Dr. Goppelsroeder ‡ reviews the applications of the electric current made by him during the last twenty years, to the production, changing and destroying of coloring matters. He shows how some organic colors are bleached by the current, others changed, and others produced from non-coloring material. By using electrodes of any desired design, acting on fabric saturated with dye, different colored designs are obtained. Or, if the fabric be saturated with a suitable electrolyte, patterns can be bleached upon it in the same way.

Tanning.—Groth § utilizes electricity in tanning by fastening the rawhides on a barrel, which is caused to revolve on a vertical axle, thus forming a cylinder, whose outer surface is pressed upon by a number of long, vertical rollers carrying the current, which is taken away by plates attached to the rollers. The rolling and squeezing force the tannin into the leather, while the electricity facilitates the absorption of the tanning material. During 1894, a plant using this process was started at Orbe, Switzerland, having a weekly output of three hundred finished skins.

Purification of Sugar Sirup.—If an impure sugar sirup be subjected to electrolysis, the organic coloring matters are destroyed by oxidation, and many of the inorganic salts present may be removed by using suitable electrodes. Schollmeyer, Behm and Danmeyer ‖ heat the sirup to 70° or 75° C., in vessels holding 1·5 cubic meters, and pass a current of 50 to 60 amperes at a tension of four volts to each vessel, using electrodes of zinc or aluminum, having a total surface of 12 to 14 square meters. The negative pole soon becomes covered with a gummy coating, which is almost pure albumen, and increases the electrical resistance, to avoid which the current is reversed every two or three minutes. The current is applied only eight to ten minutes, at the end of which time the sirup is run out into a vat and treated in the usual way with milk of lime. The advantages of the electrical treatment are that less milk of lime is needed and that the use of bone charcoal is done away with. The zinc or aluminum anodes are attacked, forming alkaline salts, which precipitate the impurities of the sugar, while the gummy aluminum hydrate brings down all suspended impurities. Daix ¶ states that one electric horse power will suffice to refine daily the sirup from one hundred tons of beet root, and that the process is in successful use in several of the German refineries.

Bacteriological Experiments.—Smirnow and Klemperer** have made some remarkable experiments concerning the action of electricity on virulent bacteria cultures. It has been proved that when active bacilli of consumption and cholera are subjected to electrical action, the electrolyzed liquid gives immunity against fatal quantities of the same bacteria. It has not been proved that it will act as an antidote after the fatal poison has entered the system. Smirnow electrolyzed albumen cultures of diphtheria poison, and found at once that, although all the bacilli therein are not killed, yet the liquid thus produced gives immunity to the system against the virulent poison. Experiments with dogs and rabbits have been conclusive, and the medical profession is hastening to apply the serum thus produced in actual practice. The possibility of extending this principle to the treatment of all germ diseases is one of the great questions of modern medical science.

Manufacture of Chloroform.—The electrical method is so cheap and expeditious that it is rapidly displacing all others. An enameled iron retort is used, having a double bottom by which it is steam heated. Two lead plates form the electrodes. A twenty per cent. solution of common salt is placed in the retort, brought to the boiling point; the current is caused to flow, and acetone is then passed continuously through the electrolyzed solution. The free chlorine generated by the

* Journal American Chemical Society, January, 1894.
† Journal of the Franklin Institute, 139, 177.
‡ Elektrochemische Zeitschrift, April, 1894, 3.
§ Elektrochemische Zeitschrift, October, 1894, 134.
‖ German patent, No. 76,858 (1894).
¶ Elektrotechniker, 1894, 201.
** Berliner Klinische Wochenschrift, 1894, 683-742.

electrolysis of the salt acts on the acetone, forming chloroform, which distills off and is collected in a suitably attached condenser. Chloroform thus prepared contains no foreign chlorine compounds, and the return per 100 parts of acetone is 190 parts of chloroform out of a possible yield of 206 parts.

Aniline Colors.—The use of the electrical current to produce oxidations and reductions in the manipulation of organic substances, particularly in producing dyes, has been carried so far that it is impossible to attempt even to enumerate them here. In general, the electrolyzer is divided into two parts by a porous partition, and, if oxidation be the objective point, the liquid is placed in the anode compartment; or, if reduction, then in the cathode cell.

Cadmium Yellow.—This valuable pigment is easily made by electrolyzing a solution of common salt with cadmium electrodes, at the same time leading a current of sulphureted hydrogen into the solution. Cadmium sulphide is continuously precipitated as quickly as cadmium chloride goes into solution, the pigment being of different shades, according to the conditions of the electrolysis.

Antimony Vermilion.—Chemically, this pigment is antimony sulphide, and may be prepared electrolytically in a manner in all respects similar to that employed in making the cadmium compound, except that antimony electrodes are used.

Vermilion.*—The following process for preparing mercury sulphide has been described. A wooden tank, one meter high and two meters in diameter, is provided with a shelf near the bottom, on which are placed saucers containing mercury, connected with the positive pole of a dynamo. The negative pole is a steeled copper plate lying on the bottom. The liquor placed in the tank contains 8 per cent. each of ammonium and sodium nitrates. A perforated coiled tube conveys sulphureted hydrogen into the tank, and an agitator keeps the whole in motion. From time to time the precipitated vermilion is filtered out.

Scheele's Green.—An 8 per cent. solution of sodium sulphate is electrolyzed with copper electrodes. The bath is heated by a steam coil, and a little sack containing white arsenious oxide is suspended in the liquid. The current forms copper sulphate and caustic soda The latter dissolves the arsenic to sodium arsenite, which at once precipitates the copper sulphate as copper arsenite, regenerating sodium sulphate. The process is made continuous by renewing the arsenic and the copper plates, and straining out the precipitated pigment.

Mitis Green.—If the arsenious oxide be replaced by arsenic pentoxide, copper arsenate is precipitated. For this purpose a solution of the oxide is allowed slowly to trickle into the bath around the negative electrode. One electric horse power produces about one-fifth of a kilo of pigment per hour.

Japanese Red.—This pigment is a lead oxide colored by eosin. It is made electrolytically by electrolyzing a 10 per cent. solution of sodium acetate with lead plates, an eosin solution being run in continuously during the operation. The precipitated lead oxide takes up the coloring matter as it is forming, and the product is separated by decantation. Rhodamin may be used instead of eosin, and zinc electrodes in place of those of lead.

Prussian Blue.†—Goebel precipitates a solution of potassium ferrocyanide by means of a ferrous salt, such as copperas; suspends the precipitate in water and electrolyzes it. The solution is acidified with 5 per cent. of an acid and put into the anode compartment of the electrolyzer. If the action be prolonged, the blue color becomes faint, and the product finally passes into a dark Berlin green.

White Lead.—Stevens ‡ electrolyzes a 15 per cent. solution of nitric acid with lead electrodes, passing in continuously a current of carbonic acid gas. The lead carbonate is precipitated continuously. Ferranti, of London, § uses a solution of ammonium acetate and incloses the anodes in porous cells. The electrolysis yields a solution of lead acetate at the anode and caustic ammonia at the cathode. These solutions are run out into separate tanks, and the ammonia is carbonated by running carbonic acid gas into it. The solution of ammonium carbonate is then mixed with that of lead acetate, precipitating white lead, and leaving ammonium acetate in solution to be used over again. This precipitation is performed with the solutions hot. The electrolyzer consists of lead plates locked together in a frame, as in a filter press, the frames being insulated from each other by porous diaphragms of stout Willesdenized paper.

This process, or one similar to it, is already in operation on an experimental scale at the works of one of the largest lead paint makers in Philadelphia.

Caustic Alkali, Soda and Bleaching Powder.—The practical electrolysis of a strong solution of common salt, producing caustic soda and chlorine gas—the former being used for making carbonate of soda and the latter bleaching powder—is of very recent development. On passing the electric current through strong brine the salt is decomposed, caustic soda forms around the cathode and chlorine is set free at the anode. The substances decomposed and the heat absorbed are as follows:

	Calories.
1 molecule of salt in solution (Na, Cl, H_2O)	96,510
1 molecule of water (H_2, O)	69,000
Sum	165,510

The substance formed and heat developed are:

1 molecule of caustic soda in solution (Na, O, H, H_2O)	111,810
Deficit of heat	53,700

$$\text{Voltage required } \frac{53{,}700}{23{,}000} = 2·33 \text{ volts.}$$

The practical difficulties encountered in this operation are to find an anode which will not disintegrate rapidly under the combined attack of nascent chlorine and oxygen, and to construct a porous diaphragm which will keep the caustic soda around the cathode from recombining with the chlorine around the anode.

* La Lumiere Electrique, 1894, 52, 376.
† Engineering and Mining Journal, January 19, 1895.
‡ French patent, No. 216,365 (1892).
§ English patent, No. 23,572 (December 21, 1893).

Greenwood saturates carbon anodes with tar and bakes them at a high temperature. Castner embeds the carbons in powdered carbon and heats them white hot with an electric current, changing them into graphite, which is more resisting. Hopfner claims that both anodes and cathodes can be replaced by ferrosilicon, cast into any desired shape.

Riekmann and Le Seur use a porous partition made of parchment paper soaked in blood and coagulated, the albumen forming the body of the diaphragm. Le Seur uses the expedient of a double diaphragm, into the center of which the fresh brine is run a little faster than it filters through. The level of liquor in the diaphragm is thus kept higher than in the cell, and as the solution flows both ways into the anode and cathode compartments, a mixing of the liquors in these compartments is thereby prevented. Hargreaves uses a screen of fine copper wire on which asbestos fiber has been deposited. This is said to be the best diaphragm yet used, lasting well and having very low resistance. Hermite has proposed a horizontal diaphragm of mercury, supported on gauze of asbestos or other non-conducting material. Castner uses a movable mercury diaphragm which will be described in detail.

Kellner avoids the recombination of caustic soda and chlorine by introducing carbonic acid gas into the cathode liquor and precipitating the soda as bicarbonate. Parker and Robinson propose, since the caustic is largely used in making soap, that fatty acids be introduced into the cathode cell, when the soap produced by the caustic acting on them floats, and may be skimmed off.

H. Y. Castner, of New York, has patented the following ingenious apparatus:* A shallow vessel is divided into three compartments by two partitions reaching from the top nearly to the bottom. The outer cells are closed by tight lids. Mercury is placed in the bottom, deep enough to reach the partitions and isolate the three compartments. In the outer cells a strong brine solution is kept circulating, and in this are placed carbon anodes, close to the surface of the mercury. Pure water circulates in the middle cell, into which dips an iron cathode. On passing the electric current, the mercury in the outer cells acts as a cathode, and absorbs metallic sodium, while chlorine gas is set free at the carbon anodes and passes into a gas main in communication with the cover. The sodium diffuses into the mercury in the center cell, the diffusion being assisted by a slight rocking motion given to the whole vessel by a suitable mechanism. In this cell the mercury acts as anode and the iron plate as cathode. The water is decomposed, hydrogen gas is set free at the cathode, while the oxygen liberated at the anode (the mercury) oxidizes the sodium in it to Na_2O, which combines with water to form caustic soda. The mercury rarely contains at any time over 0·2 per cent. of sodium. The fittings to each vessel are pipes to the outer cells to circulate fresh brine, a gas main to take away chlorine, and pipes to the inner cell to supply water and take away the caustic solution, which only needs evaporation to be in marketable shape. The plant now in operation at Oldbury, near Birmingham, England, consists of 30 decomposing vessels, a dynamo giving 550 amperes at 120 volts (4 volts to a cell), run by a 110 horse power engine. The daily output is 1,200 pounds of pure chlorine gas and 1,000 pounds of 99½ per cent. caustic soda. The plant was put in operation in July last, and probably marks the beginning of an immense industry.

Electrolytic soda plants are springing up all over Europe, wherever cheap raw materials (salt, limestone, coal) are available, and particularly where water power can be had. Already the combined output is nearly 100,000 tons yearly, and Lunge, the Mentor of the soda industry, has given it as his opinion that it is only a question of a few years when the historic Le Blanc process and the ingenious ammonia process will be entirely eclipsed.

Potassium Chlorate.—By electrolyzing a hot solution of potassium chloride, and allowing a free mixture of caustic potash, chlorine and oxygen produced, potassium chlorate results, the reaction being

$$KOH + Cl + O_2 = KClO_3 + HCl$$

F. Hurter recommends that the solution be electrolyzed in a metallic vessel which itself forms the cathode, the anode being formed of thin sheets of platinum. Haussermann and Nachold † hold it the best practice to use a porous cell inclosing the anode, around which circulates a solution of caustic potash, while potassium chloride solution is used outside. The chlorine and oxygen set free at the anode convert the caustic into chlorate, while the chloride solution is gradually converted into caustic. Strong solutions, a temperature of 80° C., and platinum anodes give the best results.

About 2,000 tons of potassium chlorate are used yearly for making safety matches. The Societe d'Electrochimie at Vallorbes, in the Jura Mountains, Switzerland, operates an electrolytic plant of 2000 horse power, and produces yearly 600 tons. The Superphosphat Aktien Gesellschaft has erected a 6,500 horse power plant at Mansboe, in Dalecarlia, Sweden, and at the present time it is probable that all the potassium chlorate marketed is produced by the electrolytic method.

Chromic and Similar Acids.—Placet and Bonnet, of Paris, ‡ produce chromic acid by electrolyzing alkaline chromate or bichromate in solution, using carbon electrodes. The cathode is placed in a porous cup filled with pure water, the anode in the chromate solution. Caustic alkali forms around the cathode, and is replaced from time to time by pure water. Chromic acid forms in the outer vessel, and may be crystallized out of the solution. The caustic alkali solution may be utilized to act on chromium minerals to produce the chromate. This principle may evidently be adapted to the treatment of other acids combined with alkaline bases, or, in general, for extracting pure acids from binary compounds.

Phosphorus.—Readman and Parker's § electric process is used by the Electric Construction Corporation, at Wednesfield, England. A mixture of calcium acid phosphate and carbon is heated to whiteness in an

* Engineering and Mining Journal, September 22, 1894.
† Journal of the Society of Chemical Industry, Sept. 29, 1894.
‡ English patent No. 22,819 (Dec. 12, 1892).
§ Industries, 1892, 168.

electric furnace between carbon electrodes, and the phosphorus distilling off is caught in a condenser. In the plant now working, an alternating current of 400 kilowatts is used. The intense heat makes the reduction much more complete than in ordinary retorts, the slag remaining containing only a small amount of phosphorus as silico-phosphide of iron, the lime having formed calcium silicate, aluminate and carbide. Albright and Wilson are said to have secured possession of the patents and will work the process.

(To be continued.)

FRAGRANCE.*

A MAN who makes a garden should have a heart for plants that have the gift of sweetness as well as beauty of form or color. And what a mystery, as well as charm—wild roses sweet as the breath of heaven, and a wild rose of repulsive odor, all born of the earth mother, and it may be springing from the same spot. Flowers sweet at night and scentless in the day; flowers of evil odor at one hour and fragrant at another; plants sweet in breath of blossom, but deadly in leaf and sap; lilies sweet as they are fair, and lilies that must not be let into the house: with bushes in which all that is delightful in odor permeates to every March daring bud. The Grant Allens of the day, who tell us how the dandelion sprung from the primrose some millions of years ago, would explain all these things to us, or put long names to them—what Sir Richard Owen used to call "conjectural biology." But we need not care where they leave the question, for to us is given this precious fragrance, happily almost without effort, and happily as free as the clouds from man's power to spoil.

Every fertile country has its fragrant flowers and trees; alpine meadows with orchids and mountain violets; the primrose-scented woods, honeysuckle-wreathed and may-frosted hedgerows of Britain; the cedars of India and of the mountains of Asia Minor, with Lebanon; trees of the same stately order, perhaps still more fragrant in the warmer Pacific breezes of the Rocky Mountains and Oregon, where the many great pines spring from a carpet of fragrant evergreens, and a thousand flowers which fade away after their early bloom, and rest in the heat, while the tall trees overhead distill forever grateful odor in the sunny air; myrtle, rosemary and lavender, and all the aromatic bushes and herbs clothing the little capes that jut into the great sea which washes the shores of Greece, Italy, Sicily and Corsica; garden islands scattered through vast Pacific seas, as stars are scattered in the heavens; enormous tropical forests, little entered by man, but from which he gathers on the outskirts treasures for our orchid houses and greenhouses; island gardens like Java and Ceylon and Borneo, rich in spices and lovely plant life; Australian bush, with traces of plant life as if from another world, but often most delicate in odor even in the distorted fragments of them we see in our greenhouses.

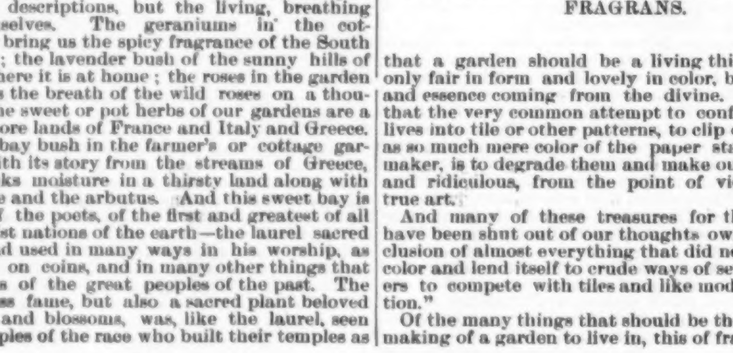
It is not only from the fragile flower vases these sweet odors flow; they breathe through leaf and stem, and the whole being of many trees and bushes, from the stately gum trees of Australia to the sweet verbena of Chile. Many must have felt the charm of the strange scent of the box bush before Oliver Wendell Holmes told us of its "breathing the fragrance of eternity, for this is one of the odors which carry us out of time into the abysses of the unbeginning past."

The scent of flowers is often cloying, as of the tuberose, while that of leaves is often delicate and refreshing, as in the budding larch, and in the leaves of balm and rosemary, while fragrance is often stored in the wood and down through the roots.

It is given to few to see many of these sweet plants in their native lands, but we who love our gardens may enjoy many of them about us, not merely in drawings or descriptions, but the living, breathing things themselves. The geraniums in the cottage window bring us the spicy fragrance of the South African hills; the lavender bush of the sunny hills of Provence, where it is at home; the roses in the garden bring near us the breath of the wild roses on a thousand hills; the sweet or pot herbs of our gardens are a gift of the shore lands of France and Italy and Greece.

The sweet bay bush in the farmer's or cottage garden comes with its story from the streams of Greece, where it seeks moisture in a thirsty land along with the wild olive and the arbutus. And this sweet bay is the laurel of the poets, of the first and greatest of all poet and artist nations of the earth—the laurel sacred to Apollo, and used in many ways in his worship, as we may see on coins, and in many other things that remain to us of the great peoples of the past. The myrtle, of less fame, but also a sacred plant beloved for its leaves and blossoms, was, like the laurel, seen near the temples of the race who built their temples as lilies are built, whose song is deathless, and the fragments of its art despair to the artist of our time.

And thus the fragrant bushes our gardens may entwine for us, apart from their gift of beauty, living associations and beautiful thoughts for ever famous in human story.



THE SWEET BAY (LAURUS NOBILIS).

It is not only the odors of trees and flowers known to all we have to think of, but many delicate ones less known of, perhaps, by reason of the blossoms that give them being without showy color, as the wild vine, the sweet vernal, lemon and other grasses. And among these modest flowers there are none more delicate in odor than the blossoms of the common white willow and yellow-twigged and other willows of Britain and Northern Europe, all the more grateful in air coming to us,

O'er the northern moorland, o'er the northern foam.

What is the lesson these sweet flowers have for us? They tell us—if there were no other flowers to tell us—

FLOWERING SHOOT OF CHIMONANTHUS FRAGRANS.

that a garden should be a living thing; its life not only fair in form and lovely in color, but in its breath and essence coming from the divine. They tell us that the very common attempt to conform their fair lives into tile or other patterns, to clip or set them out as so much mere color of the paper stainer or carpet maker, is to degrade them and make our gardens ugly and ridiculous, from the point of view of nature or true art.

And many of these treasures for the open garden have been shut out of our thoughts owing to the exclusion of almost everything that did not make showy color and lend itself to crude ways of setting out flowers to compete with tiles and like modes of "decoration."

Of the many things that should be thought of in the making of a garden to live in, this of fragrance is one of the first. And happily, among every class of flowers which may adorn our open air gardens there are fragrant things to be found. Apart from the groups of plants in which all, or nearly all, are fragrant, as in roses, the annual and biennial flowers of our gardens are rich in fragrance—stocks, mignonette, sweet peas, sweet sultan, wallflowers, double rockets, sweet scabious and many others. These, among the most easily raised of plants, may be enjoyed by the simplest cottage gardeners.

The garden borders of perennial flowers bear for us odors as precious as any breath of tropical orchid, from the lily of the valley to the carnation, this yielding, perhaps, the most grateful odor of all the flowering host in our garden land. In these borders things are sweeter than words may tell of—woodruff, balm, pinks, violets, garden primroses, polyanthuses, day and other lilies, early irises, narcissi, evening primroses, mezereon and pansies delicate in their sweetness.

No one may be richer in delicate fragrance than the wise man who plants hardy shrubs and flowering trees—magnolia, thorn, daphne, lilac—names each telling of whole familes of delightful things. Among shrubs those without any strong odor, like hardy heaths, are welcome to many who are often touched by remembered fragrance of some plant they do not always know. From the same regions where we found the laurel and the myrtle we have the laurustinus, beautiful in all our seacoast and milder districts, and many other lovely bushes happy in our climate; one, the wintersweet, even pouring out delicious fragrance in midwinter; sweet gale, azaleas, allspice and the delightful little mayflower that creeps about in the woodland shade in North America. So, though we cannot boast of lemon or orange groves, our climate is kind to many lovely and fragrant shrubs.

Even our ugly walls may be sweet gardens with magnolia, honeysuckle, clematis, sweet verbena and the delightful old jasmine, still clothing many a house in London. Most precious of all, however, are the noble climbing tea roses raised in our own time, within the past fifty years or so. Among the abortions of this century these are a real gain—the loveliest flowers ever raised by man. Noble in form and color, and scented as delicately as a June morn in alpine pastures, with these most precious of garden roses we could cover all the ugly walls in England and Ireland, and very many of them are in want of a veil.

The old way of having an orchard near the house was a good one. Planted for use, it was as precious for its beauty, and not only when the spring winds carried the breath of its myriad blossoms of cherry, plum, apple and pear. There were the fruit odors, too, and the early daffodils and snowdrops, with violets and primroses on the banks came, and overhead the lovely hardy trees that bear our orchard fruits, apples, pears, cherries, plums, medlar and quince. To make pictures to last round the year and far along them I should ask for many orchard trees on a few acres of good ground (all the better if too uneven for the plow); a rough belt of native evergreens, hollies, yew and fir on the cold sides to comfort trees and men; and with careless garlands of honeysuckle, wild rose and clematis among them here and there, and in the bank fence plenty of sweet brier, and may, and sloe.

The fence would not be cut every year into a bare and ugly line, but may, sloe and sweet brier left to bud and bloom, and the bank and hedge to form a shelter as well as a strong fence, not to be touched oftener than every ten years or so, and then when dealt with it should be woven together in the strong way usual in parts of Kent, that is, strong and tough enough to keep back an elephant. On the cool side of these sod banks the primrose and the oxlip would bloom long and well, and on all sides of them daffodils and jonquil, with snowflakes, snowdrops, wild tulips or any bulb-like thing we had to spare from the garden; and from the garden clippings, too, a few tufts of balm and myrrh to live forever among the grasses of the bank and below the wreaths of honeysuckle.—W. R., in The Garden.

* First written for McDonald's "Sweet Scented Flowers." London, 1895.

THE RUSSIAN THISTLE.

To the Editor of the SCIENTIFIC AMERICAN:

THE SCIENTIFIC AMERICAN of December 29, 1894, contained an article showing that there is a great danger threatening agriculture in Dakota. Up to the present two remedies have been put forward. The one, as stated in the number for January 12, 1895, is the proposal to change the article of production; by which is evidently intended the prevention of the exhaustion of the soil, caused by repeatedly raising the same crop on the same land. But, however advantageous the proposed plan may be in general, its application is not suitable in the present case. For, on the one hand, the virgin soil of America is so rich that there is not such a pressing need for a rotation of crops to prevent exhaustion of the soil; and, on the other hand, it is stated that the Russian thistle makes headway precisely on newly cultivated land, where also the crops thrive to the best advantage.

The second remedy proposed, in the number for January 26, is not to strengthen the article of production, but to weaken the enemy by introducing an insect or a fungoid.

Shall we more certainly and more quickly obtain our end by the application of this second proposal? Granted that an insect or a fungoid may be found in Russia capable of destroying the thistle (Salsola kali), who can tell whether the new introduction may not be noxious to the cultivation of some other useful plant? We fear, and not without reason, the too hasty application of such a remedy; especially when we see how dearly France and Germany have had to pay in their contest with the Colorado beetle and the Phylloxera vastatrix. How many vineyards have been destroyed? What sums of money have been expended? and how many regulations formed in the above mentioned countries during the past twenty years? And the result is that the people now see it would have been wiser in the beginning to study quietly the nature of the enemy, to find out a weak point.

Let us now make use of this experience and examine our present enemy, the Russian thistle. This plant makes its appearance in a new district, where it thrives with far greater vigor than in its native land. Now, what can be the cause of this? A twofold cause is possible. Either it is there hindered in its progress by insects or fungoids, as the second proposed remedy implies, or it finds in American soil something more advantageous to its growth. This latter, according to my opinion, is the true cause of the rapid and luxuriant propagation of the Russian thistle; and the saltworts, in general, have not much to fear from insects.

The word "salsola" itself suggests the remedy. A certain proportion of salt in the soil is a fundamental source of life to all salt plants—therefore, also to the Russian thistle. Our object must be to diminish this source of nourishment; for the salt plants absorb a very considerable quantity of salt, while other plants require a much smaller supply, as it serves them rather in preparing nourishing substances by dissolution than as a fundamental source of organic life. I believe the superabundant supply of salt, which the salsola demands, could be extracted from the ground without any detriment to other productions. What the salts are, and in what quantity they must be extracted so as not to hinder the growth of grain, and yet to deprive the thistle of its nourishment, it is not necessary to know exactly. But what we have to do is to let the salsola itself do the extraction of the salt.

Let a piece of land be left undisturbed to the Russian thistle, as has been done on many forsaken farms. When the seed is ripe—for at this time the plant contains its greatest quantity of salt—let the whole plant be gathered and burned in some place, removed from the future produce land, so that the salt which it contains may not return into the soil through the ashes.

Whether this procedure would obtain the desired result in the course of two or five years depends on the quantity of salt in the soil and on the rainfall, and so cannot be determined exactly. It may be added, that when a noticeable weakening of the plant has become manifest—which may be seen from the thinning of the branches—the weed may be removed in the last year, before the ripening of the seed, to prevent further spreading.

In conclusion, it may be remarked that the salt-containing ashes of the salsola might be used for the exhausted soil of Europe, and especially for sandy districts and moor land, as a substitute for potash salts, now so much used for manure.

It seems, therefore, that America need not fear the new immigrant, but rather may welcome it as a source of profit, at least so long as the thistle produces branches rich and thick with salt.

REV. MATTHEW LOEHLE, S.J.

Ditton Hall, Widnes, England.

ROOT NODULES OF LEGUMINOUS PLANTS.

By RUDOLF BEER, F.L.S.

IF the roots of a bean, pea, clover or almost any other leguminous plant be examined, a number of curious nodules or tuberous swellings will be noticed upon them (Fig. 1). These tuberosities have an in-

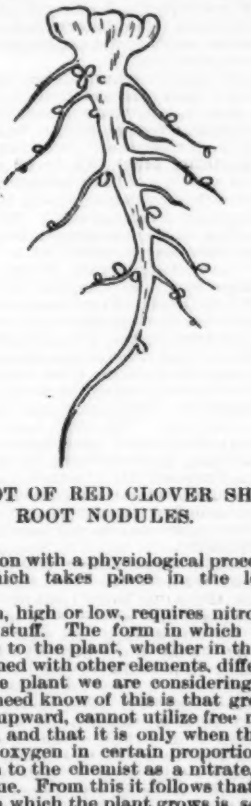


FIG. 1.—ROOT OF RED CLOVER SHOWING ROOT NODULES.

timate connection with a physiological process of great importance which takes place in the leguminous plant.

All vegetation, high or low, requires nitrogen as an item of its food stuff. The form in which this nitrogen is available to the plant, whether in the free condition or combined with other elements, differs to some extent with the plant we are considering. For the present all we need know of this is that green plants, from the Algæ upward, cannot utilize free nitrogen as a food material, and that it is only when this element is united with oxygen in certain proportion, to form what is known to the chemist as a nitrate, that it is of nutritive value. From this it follows that the nitrogen of the air in which the plant grows is, so to speak, thrown away upon at least the greater part of the vegetation of the earth. This is a point which has been put beyond all doubt by the experiments of Boussingault, Lawes and Gilbert, Pugh and others.

The useful nitrates are evidently obtained by the plant from the soil, but since no great store of these is to be found here, a somewhat difficult problem was presented to the physiologist. The only reasonable explanation seemed to be that the nitrates should be reformed as fast as they were taken up by the plants. But although this shuffled the difficulty off the shoulders of the biologist, it was only to place it all the more heavily upon those of the chemist. The formation of nitrates, either from the elements nitrogen and oxygen or from oxygen and ammonia (a compound of nitrogen and hydrogen), is, chemically speaking, a most difficult undertaking Much fruitless speculation took place in explanation of this, but it was not till 1877 that the observations of two chemists, Schloesing and Muntz, gave quite a new aspect to this tangled question. They kept samples of soil under observation for many weeks; analyzing each sample after the experiment, and knowing its constitution before, the result was that they found a noticeable nitrate increase in every instance. If, on the other hand, they treated the soil at the commencement of their experiments with an antiseptic, or subjected it to great heat, the quantity of nitrates in it remained the same after as before the experiment. From these observations they inferred that the power of nitrate formation resided in the soil and was due to living organisms in it, probably bacteria. This hypothesis, as unexpected as it was strange, opened up a hitherto untraverred path of research, which was followed in the ensuing years by Winogradsky and Frankland. In 1890, both these investigators, almost simultaneously, succeeded in isolating these soil bacteria, which previously had only existed in theory.

A little further observation showed, however, that only half the problem had been solved. What these isolated bacteria could effect was the partial oxidation of ammonia, which is abundantly present in the soil, to the intermediate stage of a nitrite. In order to furnish the nitrogen compound available to the plant, it was necessary still further to oxidize this first-formed compound, so that instead of containing only two atoms of oxygen of the nitrite, it contained the three of a

FIG. 2.—TRANSVERSE SECTION FROM ROOT NODULE OF SCARLET RUNNER (PHASEOLUS MULTIFLORUS).

nitrate. It was stated just now that only half the problem had been solved, but it was by far the most unaccountable half which was now cleared up.

Only the most powerful agents at the command of the chemist (such as ozone) were known to oxidize ammonia to a nitrite, $NH_3 + O_3 = HNO_2 + H_2O$. But once given a nitrite it is a matter of comparative ease to raise this to a nitrate, $HNO_2 + O = HNO_3$. Yet we still have to see how this second step takes place in nature. It was Winogradsky who again solved the difficulty; a short time after his former discovery he effected the isolation of a second bacterial form which was capable of bringing about the final process of oxidation. Thus the formation of nitrates in the soil must be regarded as a double act of fermentation, in which one bacterial form changes the ammonia of the soil into a nitrite and then a second micro-organism steps in and raises this to a still higher state of oxidation. During all the years in which these advances were being made, a certain discontent was simmering against the theory which gave over the vast ocean of free, atmospheric nitrogen, as a perfectly useless source, to the plant. The first reasonable doubts, based upon observed facts, which were cast upon this hypothesis emanated from the famous experimental farm at Rothamsted. In growing certain leguminous plants under carefully watched conditions there was found to be a larger quantity of nitrogen in them after the lapse of some time than could be accounted for by the available sources in the soil. There was only one conclusion to be drawn from these facts and this was that by some means not yet understood these plants had assimilated the nitrogen of the air. In and about the year 1886, Hellriegel and Wilfarth in Germany, Marshall Ward and others in this country, carried on a series of experiments with leguminous plants which all gave similar results. If a plant, the quantity of nitrogen in which was known, was grown in a pot of carefully analyzed soil, it was found that there was a considerable increase in nitrogen within this system after several weeks, which could only be attributed to a "fixation" or abstraction of this element from the air. It is upon the researches of Laurent and Schloesing that we depend, however, more than upon any others, for placing this matter upon a sure basis. These investigators were able to show, by inclosing the plant and soil in a confined and analyzed portion of air, that exactly in proportion as the plant gained in nitrogen did the surrounding air become poorer in this gas. It was found, moreover, that only particular plants, viz., those belonging to the Leguminosæ and certain Algæ, could thus assimilate free nitrogen. The point in which leguminous plants, capable of nitrogen fixation, differ from others is in the possession of the curious nodules mentioned in the commencement of this article.

The German observers, Hellriegel and Wilfarth, were the first to notice this feature and point out the further facts that these tuberosities were crowded with minute organisms and were characterized besides by containing the richest stores of nitrates in the whole plant. It was concluded, in consequence, that the Leguminosæ possessed the power of free nitrogen fixation through the presence of the nodules, and that the ultimate cause was to be found in the micro-organisms which swarmed within these. How exactly these "bacteriads," as these small bacteria-like organisms of the tuberosities are named, aid in this process of nitrification and precisely what relation they bear to the plant is still a matter of discussion.

According to a paper lately published by Professor Marshall Ward (see Nature, March 29, 1894) there are four possible theories at present existing.

1. The living cells of all plants may have the power of "fixing" nitrogen, and this only becomes more evident where root nodules are present.

2. The soil bacteria, already considered, and the organisms of the tuberosities may have powers of directly fixing the nitrogen of the air as part of their life processes, and that the nitrates thus formed are subsequently absorbed by the leguminous plant.

3. It may be that this nitrogen assimilation is a "powerful act of machinery on the part of the leguminous plant," which is stimulated to such unwonted activity by the organisms living in its root nodules.

4. Lastly, it may be that the nitrates elsewhere pro-

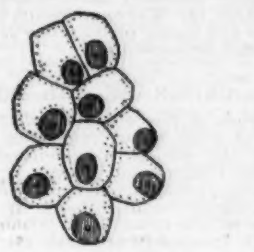


FIG. 4.—CELLS FROM PITH OF ROOT NODULE OF SCARLET RUNNER.

duced are simply gathered together by the root organisms, which are then, so to speak, devoured by the higher plant.

The first hypothesis depends chiefly for its support upon Professor Frank. It seems, in truth, to revive the old question, which, as already mentioned, was long ago believed to be decided by the work of Boussingault and others.

The second suggestion, which is due to Berthelot, perhaps brings with it the greatest plausibility. Whether it is a real factor or no remains, of course, still undecided. It may very probably be that there are several causes constantly at work "fixing" the nitrogen of the atmosphere, but a consideration of Berthelot's experiments and of the inferences he draws from these, certainly gives color to the idea that one of these is to be found in the organisms of the soil and roots, which, in the course of their vital activities, oxidize the nitrogen of the air, which then finds its way into the higher plant.

Professor Hellriegel, who was the first to notice the root nodules and their inhabitants, and to connect them with the nitrogen supply of the leguminous plant, has gone further than this, and has also attempted to explain the manner in which the organisms of the root act. He says that these bacteriads do not themselves bring about the fixation of nitrogen, but that they act upon their host plant, stimulating its cells to unusual activity. The result of this increased vitality is shown in the direct assimilation of atmospheric nitrogen by the living cells of the sub-aerial parts. To any one unacquainted with the unlooked-for responses which protoplasm frequently gives to stimulation, this theory may appear extravagant. But in the light of other facts connected with the so-called phenomena of irritability this view is one deserving careful attention. The last of the above-mentioned hypotheses is also by no means an improbable one. There can be little doubt that there are numbers of non-living agencies which fix small and much scattered quantities of nitrogen, and it may be that the bacteriads simply draw together and consecrate this widely-spread store, which then becomes available to the host plant. Still it must be admitted that it is very doubtful whether the nitrogen, "fixed" by inanimate causes, is sufficient to meet the large demand made unceasingly by the vegetation covering the face of the earth.

A fact which should be borne in mind in all these inquiries is that, of all parts of the plant, the nodules seem to be richest in nitrogen compounds. Whether these are formed here, or whether they occur simply as reserve substances, is apparently the undetermined point. However these nitrogenous substances originate in the cells of the tuberosities, they are utilized by other portions of the plant by the breaking down or absorption of the cells of the nodule. This conclusion has been particularly emphasized in the mind of the present writer by the observation that so many of the nodules have certain areas of the otherwise active cells undergoing dissolution and apparently absorption by the other tisues of the plant. Such a "corroded" area is shown in Fig. 2.

Little need be said concerning the anatomy of the

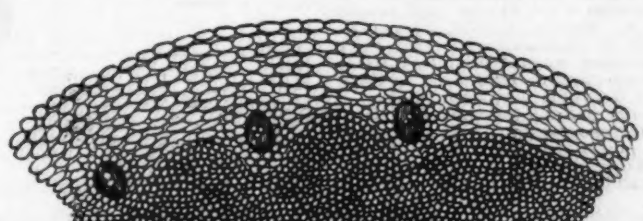


FIG. 3.—TRANSVERSE SECTION, FFOM ROOT NODULE OF SCARLET RUNNER.

nodules. This can be gathered from the sketch given in Fig. 3. On the extreme outside of the tuberosity there are corky cells, within this the living cells of the cortex, then are to be noticed the fibro-vascular bundles (three are shown in the figure), and within the ring of these again comes the pith which forms the main mass of the root swelling. A few cells of this pith have been drawn under high powers in Fig. 4. The most noticeable point in these cells is their evident protoplasmic contents and large shining nuclei, both of which facts are evidences of extremely active vitality, which we may well suppose to be in some way connected with the "fixing" of the free nitrogen of the air by the leguminous plant.

That the bacteriads of the root are of the utmost use to the higher plant is evident from the above considerations, but there is very good reason for thinking that the benefit is not altogether onesided. It would seem, partly by analogy with experiments made by Kossowitsch and others on Algæ, partly on other grounds, that while the bacteriads furnish or aid in furnishing the leguminous plant with nitrogenous materials, the green plant in its turn provides the micro-organism with the equally necessary carbo-hydrate food, such as sugar, starch, etc. The relationship, therefore, between the lower and higher plants is one of symbiosis or commensalism.—Science-Gossip.

ORIGIN OF THE POTATO.

THE origin of the cultivation of the potato was the subject of some recent interesting communications made to the Societe d'Agriculture, of France, by Messrs. De Vilmorin and Heuze.

The potato grows spontaneously in Peru and Chile, in the southern Cordillera and in the adjacent islands. It is especially in Chile that it is found in a wild state. Authentic documents establish the fact that it was cultivated in South America upon the coast of the Pacific long before the conquest of America (1492) by the Spaniards.

The first historians of the country mention the potato among the food products in common use among the Peruvians, and they note the existence of white, yellow and red tubercles.

Acosta, a Castilian writer, and the treasurer of Peru in 1514, described it at about that epoch. From America it was carried to Spain and then to Italy.

Certain authors claim that Olivier de Serres, the patriarch of French agriculture (1535–1619), made it known in France as a forage plant. Others express doubts as to whether the plant that he mentions by the name of "cartoufle" was the potato or the Jerusalem artichoke.

At the end of the sixteenth century the potato was known in Italy by the name of taratouffli (earth truffle).

The naturalist of Arras, Charles de l'Ecluse (Clusius), professor at the Academy of Leyden, received in 1588 two tubercles that had been carried from Italy to Mons, in Belgium, by one of the attendants of the Pope's legate. He cultivated these and described the plant in his History of Rare Plants, in which he states that in a short time it spread rapidly throughout Germany.

The first potatoes that reached England were taken thither by the colonists sent out by Sir Walter Raleigh in 1584, and who returned in 1586. They were planted on Sir Walter's estate, near Cork, and were used for food in Ireland long before they were even known or cultivated in England.

According to Humboldt, the culture has been carried on on a large scale in Lancashire since 1684, in Saxony since 1717, in Scotland since 1728, and in Prussia since 1728, and, according to Thaer, it became general throughout Germany after the famine of 1771.

Recommended in France by Casper Banhin, the culture rapidly spread throughout Franche Comte, the Vosges and Burgundy in 1592. But soon afterward, like so many other useful things, it underwent the ordeal of persecution. "Seeing," says a decree of the parliament of Besancon, "that the potato is a pernicious substance, and that the use of it may occasion leprosy, it is forbidden, under the penalty of an arbitrary fine, to cultivate it in the territory of Salins." In Lorraine, in the jurisdiction of the parliament of Nancy, it was submitted to a tithe, collectible by virtue of an ordinance of Duke Leopold of March 4, 1719. In 1761, Duhamel strongly advised the culture of it as being a most useful product. Turgot had the Faculty of Medicine deliver him a certificate stating that the potato was a substantial and wholesome food. Thanks to the encouragement of the illustrious minister, the cultivation of it was begun in the open fields in Limousin and Anjou.

In 1765, Monsignor du Bawel, bishop of Castre, distributed it to the curates of his diocese and taught them to cultivate it. Finally, in 1778, Parmentier undertook the work of popularizing it that every one knows. Among other ways of bringing it to notice, Parmentier gave a grand entertainment at Paris, at which Benjamin Franklin, Lavoisier, and many other celebrated men of that day were present. Every dish consisted of potatoes dressed in an endless variety of form and fashion; even the liquors were the produce of this precious root; and it is only to be regretted that the bill of fare and the recipes of the cooks have not been preserved.

The English name "potato" (from Haytian batata) is, as perhaps well known, a misnomer, it properly belonging to the sweet potato (Batatas edulis), from which it was transferred by the botanist John Gerard, "because," as he says, "it hat not onely the shape and proportion of [sweet] Potatoes, but also the pleasant taste and vertues of the same." Gerard recommends the roots to be eaten as a delicate dish and not as common food.

In England, in the time of James I, potatoes were so rare as to cost two shillings a pound, and in 1619 they are mentioned among the articles provided for the royal household. In 1633, when their valuable properties had become more generally known, they were deemed worthy of notice by the Royal Society, which took measures to encourage their cultivation with the view of preventing famine; but it was not until nearly a century after this date that they were grown to any great extent in England.

In this country, potatoes are mentioned in Pennsylvania soon after the advent of the Quakers in 1682. They were not among New York products in 1695, but in 1775 we are told of eleven thousand bushels grown on one sixteen acre patch in this province. Potatoes were served, perhaps as an exotic rarity, at a Harvard installation dinner in 1707; but the plant was only brought into cultivation in New England at the arrival of the Presbyterian immigrants from Ireland in 1718. Five bushels were accounted a large crop of potatoes for a Connecticut farmer, for it was held that if a man ate them every day he could not live beyond seven years. Potatoes were designated by the epithet "Irish" at an early period, because great quantities of them were annually imported into Jamaica from Ireland.

THE DECOHORNE SOLAR REGULATOR.

THE law of March 14, 1891, defines as the legal hour in France the mean time hour in Paris. The exact determination of the legal hour is necessary in many cases in civil life, and a simple apparatus which will give an approximation to the standard hour with an error of only one-half minute has long been desired, and the apparatus of M. Decohorne, of the Ponts et Chaussées, appears to answer admirably. It consists of a modified sun dial of copper, made in the form of a cylinder, the inner concave surface only being used, the general plan of the instrument being shown in Fig. 1. The axis of the cylinder is parallel to the axis of the earth and serves as the marker. Lines are

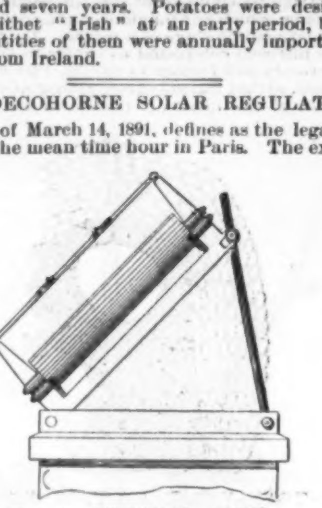


FIG. 1.—GENERAL VIEW.

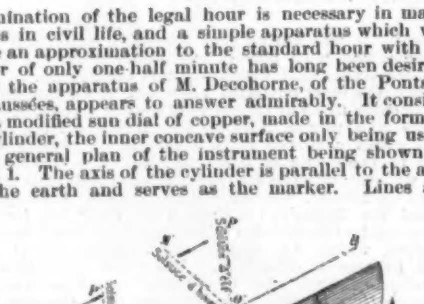


FIG. 2.—DIAGRAM OF THE APPARATUS.

traced on the concave surface of the cylinder, but these are not right lines, as in the ordinary sun dial, but curved lines as shown in Fig. 3, there being one for each ten minutes between the hours of ten in the morning and two in the afternoon, between which hours the instrument can only be used. The apparatus is usually mounted on a pedestal, so that it can be readily used. The axis of the instrument is set north and south with the aid of a compass, correction being made for the magnetic declination as given by the

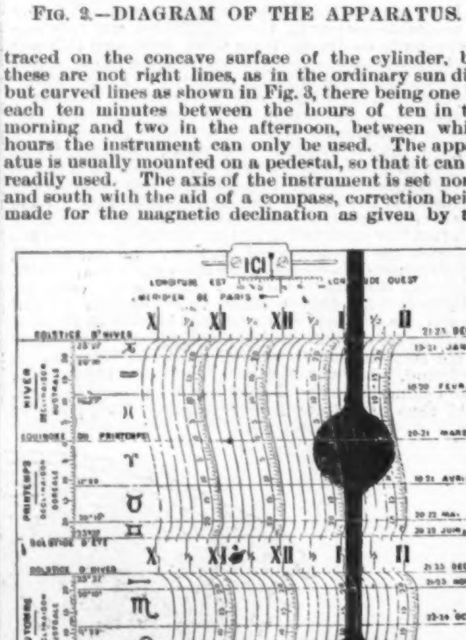


FIG. 3.—PLAN OF THE DIAL.

Annuaire du Bureau des Longitudes. The portion of a cylinder used as a dial is supported in a proper frame, and this frame may be raised and lowered according to the latitude of the place. The bar which carries the diaphragms is also capable of being adjusted. In Fig. 3 will be noticed plates on which arrows are engraved; on the copper cylinder are graduations which permit of the instrument being set to the proper degree of longitude and, at the same time, shows roughly the number of minutes that the time of the place where the instrument is located is faster or slower than that of Paris. The mean time curves traced upon the cylinder would be difficult to read except for the peculiar device which has been adopted. The axis, A B, of the cylinder is a metallic bar and carries the two diaphragms, O and O' (Fig. 2). When the sun shines in the direction, P to M, or from the summer toward the winter solstice, the diaphragm, O, is used, but when the sun shines in the direction, M' to P', or from the winter to the summer solstice, the diaphragm, O', is used. The part, Q N, contains all of the curves for determining the time in the summer and fall, or from June 20–22 to December 21–23, while the part, Q' N', includes the curves necessary to tell the time from December 21–23 to June 20–22. The small hole in the diaphragm permits a ray of sunlight to indicate the time on the dial or cylinder.

The apparatus will prove of service in isolated localities where it is important to know the legal or railroad time. It has the advantage of giving the time for four hours accurately instead of at twelve only. For our engravings and the foregoing particulars we are indebted to Le Genie Civil.

BARON VON TOLL'S EXPEDITION TO THE NEW SIBERIAN ISLANDS.

By CARL SIEWERS.

IN 1889 the Imperial Russian Academy of Sciences had received from the well-known Siberian merchant Mons. Sannikoff information to the effect that the body of a mammoth had been discovered under the seventy-third degree of latitude, on Balakhna River, which flows into Khatanga Bay, and Baron Toll was at once invited to take the leadership of an expedition for the investigation of the discovery. The bad state of the baron's health compelled him, however, to decline the offer, and Mons. Chersky was sent out to make collections of post-tertiary mammals in the far northeast, on the Rivers Yana, Indighirka, and Kolyma. After Chersky's untimely death, the proposal to start for the Khatanga was renewed to Baron Toll, and it was decided that he should not only examine the mammoth find—which after all might prove to be of no importance—but also make a general exploration of the very little known Anabar region. He left St. Petersburg on January 2, 1893, in company with Lieut. Shileiko, who undertook the topographical and astronomical work of the expedition, as well as the magnetical observations.

After a short stay at Irkutsk, they traveled to the Aldan, whence they proceeded in reindeer sledges. The Verkoyansk range was crossed by the Tukulan Pass, five thousand feet high, and from Verkoyansk the explorers went westward, across the Omoloi Mountains, to Kazachiye, which was reached on April 8. Talking there with his old acquaintances, Baron Toll came to the conclusion that he would be able to make, in this same spring, an excursion to the New Siberian Islands, traveling in dog sledges on the ice. He started immediately after Easter, with Mons. Sannikoff and several men, to visit the place where the mammoth body had been seen, one hundred and seventy miles northeast of Ust-Yansk. Four days later they began operations and in two days the men, who had already won some experience in this sort of work during a previous expedition, had reached the mammoth.

However, Sannikoff's hopes were not fulfilled. Only small pieces of the skin, with the wool attached, parts of the extremities, and the lower jaw of a young mammoth were unearthed. The skull had long since been broken, and the tusks had been taken away. These relics were all lying in recent alluvial sands, deposited by the Sanga Yuryakh River, which had washed them out from the underlying post-tertiary beds. It was, therefore, decided to return later to the spot when the snow would be gone, and in the meantime to pay a visit to the islands.

On May 1 the two explorers, accompanied by one Cossack and three Lamutes, left the mainland and landed on the south coast of the Malyi Lyakhov Island. Work was begun at once, and at the very start Baron Toll came across the interesting fact that under the perpetual ice, in a sweet water deposit, which contained pieces of willow and bones of post-tertiary mammals (the mammoth layer), were complete trees of Alnus fruticosa, fifteen feet long, with leaves and cones. It was thus evident that during the mammoth period tree vegetation reached the seventy-fourth degree of latitude, and that its northern limit was at least three degrees further north than it is now. The importance of this discovery is self-evident. Moreover, at this spot, as well as during further exploration, especially on Kotelnyi Island, the origin of the thick layers of ice which are seen everywhere under the sweet water post-tertiary deposits of the New Siberian Islands could finally be settled. It was obvious that this ice did not originate from snow; for it has everywhere a granular structure, and must thus be considered as originating from the ice sheet of the glacial period.

As to the present conditions of climate and animal life, they appeared under quite a different aspect from what they were in 1886. In that year, even on May 13, the temperature was 6° Fah.; while in 1893 it was raining on May 6, on the great Lyakhov Island. True, this was the first rain of the season, and it was followed by snow storms, but it was a forerunner of summer. The first winged guests made their appearance on Kotelnyi Island in the middle of May; the gulls taking the lead, then the geese, followed by turkans, skuas, and others. The latter found plenty of food in the mice, the only winter inhabitants of the islands. The mice displayed a feverish activity; some of them migrated from one island to the other, others migrated to the continent, while others again came from the continent to the islands.

On the return journey, frosts became less and less frequent, and the travelers had to drag their sledges themselves, as the ice hummocks, which are all cemented together by hard snow during the winter, were now loose and surrounded by water. Notwith-

standing these difficulties, the return journey of one hundred and fifty miles was performed without accident and all the instruments and collections were safely landed on the mainland on June 8.

The second part of the journey, over the tundras and across the Khara-ulakh range to the Lena, was accomplished on reindeer back, the expedition dividing into two parties at Aijergaidakh, as Baron Toll wished to revisit the mammoth remains. Now that the snow had gone, it was seen that only parts of an incomplete corpse were buried at this spot, and no further relics could be unearthed.

The ride on reindeer back from the Svyatoi Nos to the Lena, a distance of eight hundred miles, proved that the tundras can be crossed at any time of the year if the traveler rides a good reindeer, which easily crosses the most swampy places, but, in addition, a vyetka—that is, a boat for crossing rivers, made out of a poplar tree, or of three large planks—is useful. During this journey the two explorers had again an opportunity of making a fuller acquaintance with the peculiarities of the Polar climate. In July, on the shores of the Arctic Ocean, in lat. 72°, the temperature was 93° Fah., and the sky remained quite clear all the time.

After having crossed the Khara-ulakh range in two separate parties, they met together at Kumakh-sur, where they took a boat and explored the Lena and its delta.

On August 24 the expedition started westward in a long caravan of nearly fifty reindeer, in order to explore a region which had not been visited by a European for more than one hundred and fifty years, since the time of Lapteff and Pronchishcheff. They had only one guide, a Dolgan, and five Yakuts. The chief aim of the expedition, the bay of the Anabar, was reached on September 2, at Cape Buskhaya. Good weather set in, and for a full month they had a succession of bright, warm days. Lieut. Shileiko was thus enabled to make a fundamental survey of Anabar Bay, as well as of the Anabar River, as far as the mouth of the Uja, at the limits of tree vegetation—that is, for a distance of two hundred and seventy miles. At the same time the high crags of the bay and river (attaining in places heights of three hundred feet) afforded Baron Toll the possibility of obtaining a full picture of the geological structure of the region, and he gathered a rich collection of the fauna of the lower chalk deposits, of which the plateau between the Lena and the Anabar, and probably also the country further north, up to the Khatanga, is composed. In the five different horizons of the lower chalk, which he thus investigated, he found all the Mesozoic fossils, and especially the ammonites of doubtful age, which had previously been found in North Siberia, either isolated or in bowlders, and thus he was enabled to ascertain their proper place in the succession of fossils of that age.

After having completed their work on the Anabar, the explorers, instead of returning by the already known route to Bulun, took a new one, and connected their surveys with Dudinskoye on the Yenisei. Baron Toll, having to return to Bulun for his collections, parted company with Lieut. Shileiko, who lost no time in moving westward.

Meeting again at Khatangskoye, the two explorers started for their home journey, which they accomplished with remarkable rapidity. It took them but thirty days to reach Yeniseisk, and twenty-three days later they were at St. Petersburg.

The results of the expedition are encouraging. Over three thousand miles were surveyed, being based upon thirty-eight points, astronomically determined; nine months of meteorological observations in the tundras were noted; hypsometrical measurements along the whole of the route were made, while one hundred and fifty photographs and very rich collections of botanical, zoological and ethnographical specimens were obtained.

It should be added that Baron Toll was also to keep a good lookout for the Fram and the Nansen expedition, which, as originally settled, was to call and even winter at the New Siberian Islands, but as no traces whatever were found of that expedition, it is concluded that Nansen found the sea so open to the northeast that he did not call, in order to avoid delay, but steered direct into the Polar pack, which he believes is to carry him across the pole and south to Spitzbergen.—Knowledge.

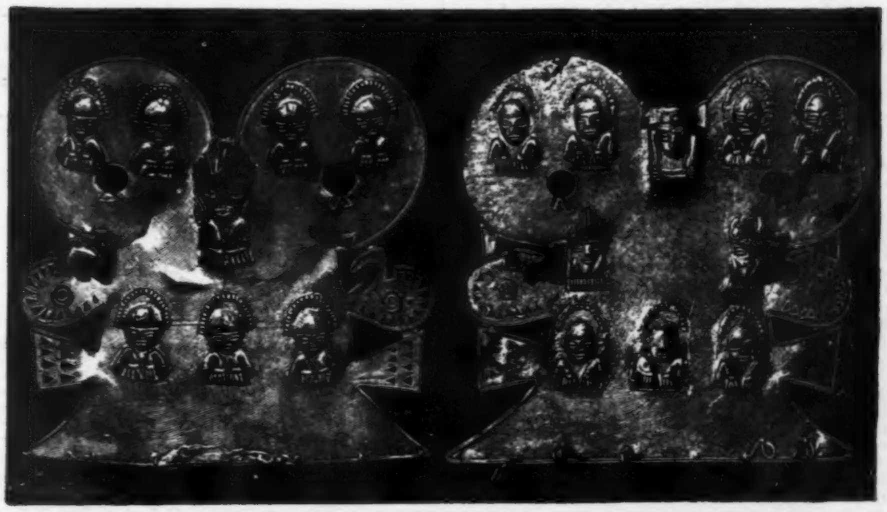
WHAT IS DEATH?

THE nature of death we conceive from our knowledge of it in man and the higher animals, and conceive it erroneously. For with the higher animals, what we call death is a sudden cessation of the gross functions of the body. There is a moment at which the watchers say "this, that was alive, is now dead." Death has come by one of the atria mortis, the three gates; by failure of the heart, or the lungs, or the brain, the mechanism has broken down and stops suddenly and visibly. Even in old age, when there has been a slow degeneration of all the organs, the final arrest of their functions comes sharply, at a particular moment. But this suddenness is no part of the real nature of the event. The point of time varies with the skill of the surgeon, and with the appliances at his disposal. It is not until long after the moment at which it seems to us that the spirit has left the body that the tissues are dead. For hours afterward the skin remains alive, the hairs grow, the sweat glands are in repulsive activity, while the muscles respond to electrical stimulation by nightmare contortions. The body of a man is a highly integrated structure; each organ has a communion so intimate with every other that failure of any part is reflected upon the whole, and the breakdown of heart, or lungs, or brain, brings slow but irremediable disaster upon the whole body. In this we have to distinguish two things: what we call death—the sudden arrest that is an accident of the complex harmony of the body, as when a steamship is stopped in midocean by the rupture of a valve—and the actual death of the living protoplasm of the cells and tissues.

In the descending scale of animal life, the relations between the organs are less and less intimate, and the misleading suddenness of the arrest of their machinery fades away. The heart of a turtle, from which the brain has been removed, will continue to beat for days. A worm or a star fish may be cut in pieces, and each piece remains alive, sometimes even reproducing the whole. Who shall name the point of death of an oyster, or of a sea anemone? No stoppage of a single organ causes sudden death and conspicuous change in the whole; when protoplasmic death of a part occurs, either the part is sloughed away and replaced or the ripples of destructive change spread slowly from cell to cell, each unaffected part remaining active to the last. In the simplest animals of all, organisms that consist each of a single cell, death may be seen at its lowest terms. There is no composite multicellular body, no bodily mechanism to break down, no possibility of the failure of one set of cells gradually creeping upon others. Each organism is alive or dead as its protoplasm is alive or dead.

Here, in their simplest forms, are life and death; and here, asking if death be inherent in living matter, we find surprising answer. Violence of heat and cold, mechanical forces, and the assaults of chemical affinities may destroy these single particles of life; but if not overthrown by rude accident, and if provided with food and drink, their protoplasm lives forever. Each particle feeds until, outgrowing a convenient size, it cleaves asunder and the one life becomes two lives. So far as reason and observation can inform us, the living particles in the ponds and seas of to-day have descended in a direct continuity of living material from the first dawn of life. No other solution is open, save the possibility of a spontaneous generation of living matter so continual and so common that it could not have eluded the search of science. This is that "immortality of the protozoa" hinted at by Lankester in England, blazoned into fame by Weismann.

Whether or not the protoplasm of the tissues of higher organisms be potentially immortal can be only a matter of inference. The reproductive cells, indeed, form a living chain, binding the animals and plants of the present with the animals and plants of the remotest past. This reproductive protoplasm is immortal in precisely the same sense as the protoplasm of single cells is immortal, and there seems no reason to believe with Weismann that the protoplasm of the other tissues has acquired mortality, and is different in kind. It dies, but only because it is part of a complex structure. The machinery of the body is not



ABORIGINAL BREASTPLATES OF GOLD, DISCOVERED AT MACHETA, COLOMBIA.

regulated to last forever; on the other hand, it is to the advantage of the race that it should break down when reproduction has been accomplished, and its breakdown results in the ruin of its component parts. There is no reason to suppose the protoplasm itself grows old. A slip cut from a tree many centuries old may be grafted on a young tree and so enter on a new lease of life. Were the process to be continued, a continuity of protoplasmic life might be maintained. So far as we can tell, death is not inherent in living matter. Protoplasm may live forever, as a flame shielded from the wind and fed from an endless store would burn forever.

Interesting as it may be, this triumph over death is barren and formal in the sense that affects us most. The life that endures is life only in an abstract sense. It is individual life that appeals to our emotions, individual death that broods over our joys. Even among the protozoa, the individuals that come in being are new individuals, the parent divided into two is as surely dead as if a corruptible body were left behind. Mortal man and the immortal protozoa have the same barren immortality; the individuals perish, living on only in their descendants, creatures of their body, separated pieces of their undying protoplasm; the type alone persists.—London Saturday Review.

MICROBES AND METALS.

THE effect of metals on the growth of bacteria has been examined by Miller, Behring, and others, and another contribution to this subject has lately been published by Dr. Meade Bolton, in the December number of the International Medical Magazine. According to Uffelmann, who smeared the surface of copper coins with liquefied jelly cultures of cholera bacilli, the latter were destroyed in seventeen minutes; while on a brass coin they were alive after thirty hours, but dead after sixty hours. Bolton employed Miller's method of inoculating a tube of melted jelly with particular microbes, and pouring the contents out on a sterilized glass plate, after which bits of the metal under examination were laid on the jelly while it was still soft. If the metal has an inhibitory action on the microbes, then a clear zone is left around the metal after the colonies have developed in the other parts of the jelly. The width of this zone, Dr. Bolton found, varied very considerably with different organisms, as well as with different metals. Thus carefully purified bits of silver produced in the case of cholera bacilli a clear zone 5 millimeters broad, in the case of typhoid bacilli a zone of about 1 millimeter, while with the closely allied colon bacillus a zone of about 5 millimeters was produced. In the case of purified gold, no inhibition was observed with the staphylococcus pyogenes aureus, colon bacillus, typhoid bacillus, or cholera bacillus. Freshly "glowed gold" had invariably no inhibitory action; and in the few cases where inhibition was observed, the gold had not been glowed for several weeks. Pure nickel, platinum wire, and platinum black aluminum, silicon, and niobium, again, also failed to give any reaction with most of the microbes examined. Throughout the investigations it was found that those metals that are resistant toward chemical reagents in general failed to produce any effect on microbes; while, on the other hand, those metals which are readily attacked by chemical reagents all exhibited a marked inhibitory action upon the growth of bacteria. This result is probably due to a solution of the metal taking place in the medium. The length of time it is necessary to leave the metals in contact with the jelly, to produce an effect on the microbes present, was tried with brass, copper, cadmium, and zinc, on the staphylococcus pyogenes aureus. The metals were put on and removed at various intervals. When cadmium was left on for a minute, there was a clear space underneath where it had rested, which extended to 1 millimeter round; when it was left on for three or four minutes, the clear space usually extended over 3 millimeters. Very similar results were obtained with zinc. With brass no effect was produced when it was left on thirty-six minutes, but after this there was more and more marked inhibition up to fifty minutes; but to produce a clear space, it was necessary to leave it on for still longer. Copper produced no visible effect under thirty-six minutes, and fifty minutes was required to produce a clear space.—G. C. Frankland, in Nature.

AN ARCHÆOLOGICAL DISCOVERY IN COLOMBIA.

MR. J. DE BRETTES, who is at present exploring the republic of Colombia, has just sent some photographs to the Geographical Society of Paris, one of which we reproduce herewith. It represents two of the breast plates recently discovered in a grotto in the Sierra Nevada, near Macheta, Colombia. The originals, which are of solid gold, have been offered to Pope Leo XIII by the government of Colombia.

The principal interest of these ornaments, which are executed with much art, and at the same time have a somewhat naif aspect, resides in their resemblance to the insignia once worn by the Jewish and Assyrian high priests. Various attributes by which they are surrounded render it supposable that they belonged to the cacique warriors. One of these plates, the largest one, measures no less than 8 by 10 inches and weighs over 12 ounces. The three other plates are of slightly smaller size.

As may be seen from the engraving, these "petos" are ornamented with figures in relief. Besides, at their extremities, they are provided with rings that were probably designed to receive different objects, such as chains, balls and fetiches.

The manufacturers of these little masterpieces of art appear to have been the Chibchas, an aboriginal people of the present territory of Colombia, considered as the nation that was of old the most civilized one of the South American continent, and which was acquainted with the secret of casting metals.—La Nature.

THE WHITE CLIFFS OPAL FIELDS, NEW SOUTH WALES.*

By F. G. DE V. GIPPS.

THE White Cliffs opal field is situated in the Parish of Kirk, County of Yungnulgra, New South Wales, about 60 miles from Wilcannia and the River Darling. It is near the southern edge of the cretaceous basin of the interior of Queensland, New South Wales and South Australia. The opal-bearing country, so far as at present known, follows a more or less well defined line running north and south toward the northern end of the field, and northeast and southwest toward the southern extremity.

The course of the opal field, over its length of about 15 miles, and width of from half a mile to nearly 2

* Abstract of paper read before the Ballarat Session, Australasian Institute of Mining Engineers, March, 1894.

miles, is more or less marked on the surface by large angular bowlders of sandstone and quartzite. Below the surface, except where considerable erosion has taken place, are other bowlders of sandstone and quartzite, but these appear to have been introduced during the latter part of the cretaceous period, and, in contradistinction to the angular surface bowlders, which are un-fossiliferous, those found actually in the opal-bearing beds are harder, rounder and more waterworn, some being highly polished, and many of them contain characteristic Devonian fossils. These lower bowlders also contain proof of the deposition of opal during a very extended period, as I have obtained among them some which show that they have had opal introduced into them while in a state of considerable porosity. They have then been waterworn very smooth, and subsequently, by pressure or some other cause, broken and re-cemented together by opal, the portions of the bowlder having in some cases shifted a quarter of an inch or so, and appearing to indicate the action I have described. While on the subject of the duration of the period of opal deposition, I may mention that fully 99 per cent. of the opal obtained on the field is of no value, some of it being common or semi-opal, and much, although of the noble variety, containing little or no color, being very cloudy or too watery, carrying the color only in minute bars or streaks, or being stained a reddish-yellow by iron (the latter being known locally as "sandy whisker"). In some instances I have found veins or seams of the colorless opal with the edges of the cracked and separated pieces coated with a thin film of finely colored opal. An unbroken vein of opal, however small, is never found; it having, after deposition, been broken into larger or smaller fragments, which, however, still retain their relative positions in the vein. This fracturing is evidently due to contraction on hardening, the contraction having doubtless produced the internal strains of conchoidal relation to which the coloring of the opal is most probably due. With regard to the color, however, I may mention that opal obtained in dark, damp, ferruginous clays, or in the thin bands of laminated iron-stone, which are of common occurrence, is generally darker and richer in color than that from the white or light colored kaolins and siliceous beds. It is usually very clear in color when in a band of gypsum (commonly known as copi); and especially so when the gypsum is crystallized, and where I have found it in contact with gypsum crystals it has always the appearance of having been eaten into by the gypsum. Lead, in the form of a mixed carbonate and sulphate with some gypsum, exists in many places on the field, occurring in small bun-shaped lumps of from ¼ to 1 pound in weight all through the clays and kaolins, but I have been unable to trace any relation between this and the opal, and can offer no explanation of its occurrence in this form. These lumps of lead have always a small depression on the lower side, and a small cavity in the center containing minute crystals of lead. The form is always the same, that of a bun with the flat or rather slightly concave side downward. There is another peculiar form common on the field known as a "nigger head." These nigger heads are usually oval or spherical masses of more or less opal-impregnated, fine grained silica; they are of all sizes from a pound to a hundredweight, and almost always contain a center of opalized wood, often also containing opal of good color in cracks caused by contraction. A similar material to that forming the nigger head is also found in masses containing wood and shells, and as "bandstone."

The "bandstones" appear to bear a marked relation to the opal deposits. They are flat bands, usually of harder nature than the adjoining strata, and often contain opalized shells, and sometimes belemnites, and have usually cracks which have been filled with opal. The seams of opal are usually formed either just above or below the bandstone, generally the latter. This bandstone has been the position for some considerable period of the bottom of the water, to judge by the shells, etc., it often contains. There may be more than one bandstone, one being sometimes 2 or 3 feet or more below the other. The "nigger heads," likewise looked upon as a good indication of opal, also naturally occur at what has been the sea bottom for some considerable period. Where the opal in these indicators is of good color, it is likely to be so also in the veins which occur near them. A solution of some alkali, such as lime, etc., percolating through the fine silica of the beds, probably in part already in a soluble condition, would naturally dissolve out a portion of it and redeposit it in cracks and cavities as opal. There can be no doubt that the opal has been of a gelatinous nature during deposition, as I have frequently observed various matters, such as small particles of ironstone, clay, etc., held in suspense in clear opal, as in the case of ants and flies in amber, nothing supporting them. This is especially noticeable in some of the opalized wood, fragments of wood, etc., being scattered about in the large veins of clear opal which some of it contains. I may mention that I have seen much silicified wood containing veins of chalcedony, but in none have I seen suspended matter as with the opal.

The fact also of all the veins, whether horizontal or vertical, having been broken up, apparently by contraction on hardening, would point to a gelatinous condition.

There is another point in favor of this, which is that when the color of the individual stones varies or is not true in the vertical seams it is banded across the stone, in the horizontal veins it is along the stone; the bands of color, whether in the vertical or flat veins, being as near as possible horizontal, thus differing from the usual arrangement of veins of silicious or other matter, which are generally banded from the sides toward the center, especially when vertical. This, in conjunction with the suspended matter in the opal, proves that the veins and cavities have not been subject to gradual deposition from silicious matter in a circulation of water, but have been filled by a gelatinous solution of silica, more or less pure, which has had time to settle into zones or horizontal bands, according to its density or specific gravity. I have seen many vertical veins with half an inch to an inch of good opal at the top, but with that immediately below discolored by foreign matter, and often quite opaque and stony looking. In no instance have I seen this order reversed, that is, the base stuff on top and good opal below, although it is often not true, that is to say, it is in horizontal bands of varying color. Owing to this, as a general rule the vertical veins, even when consisting of good colored opal, are not of such good quality as the horizontal.

In addition to veins, the opal is commonly found in pseudomorphic forms, after shells, belemnites, etc. Some of these, when of good color, are very beautiful, though as a rule the shells are much fractured, and being very thin the opal, though often of most vivid color, is not salable. The belemnites, being thicker, are valuable when of good opal. They are locally known as pipe opal, though of quite distinct nature from the pipe opal of Queensland, the latter having filled long narrow cavities in a dense sandstone.

There is a wide variety of opal found on the field, and the prices paid locally run from zero to about £25 per ounce, the ounce being the unit for purchasing in the rough. It is rarely that the price paid exceeds £20 per ounce. In valuing opal a good many points have to be taken into account. Color is the first, red fire or red in combination with yellow, blue and green being the best. Blue by itself is quite valueless, and green opal is not of great value unless the color is very vivid and the "pattern" good. That the color should be true is a vital point. However good it may be, if it runs in streaks or patches alternating with colorless or inferior quality, that is "untrue," it is of comparatively small value.

Pattern is an important factor in the value, the various kinds being distinguished respectively as "pinfire," when the grain is very small; "harlequin," when the color is all in small squares, the more regular the better; and "flashfire," or flash opal, when the color shows as a single flash or in very large pattern. Of course there are many intermediate classes.

The "harlequin" is the most uncommon and also the most beautiful. When the squares of color are regular and show as distinct minute checkers of red, blue, yellow and green, this class of opal is truly magnificent.

The flash opal is often very beautiful in color, especially when of the true ruby or "pigeon's blood" color. As a rule, however, it shows green or red flash, according to the angle at which it is held.

It is difficult to obtain separate stones of absolute similarity in color and pattern, therefore for suits of jewelry a large true stone from which the whole could be cut is worth a great deal more per ounce than so many smaller stones approximately similar. Again, the ground or body of the opal must be taken into account. This is not a constant quantity, as the various patterns require slightly different ground. It should neither be too transparent nor too opaque: almost clear, with a slight milky tinge, translucent being about the best ground in general. Some of the opal is more brittle than other. Of course the harder and tougher the stone the better it is, as when cut it is less likely to be injured and retains the polish better.

[FROM THE EPOCH.]

FORESTS TURNED TO STONE.

THE Yellowstone National Park is called the Wonderland of America, and since the destruction of the New Zealand geyser area, it is, perhaps, entitled to be called the wonderland of the world, for within its limits the most varied of Nature's workings may be observed. Its hundreds of hot springs and geysers, its precipitous canons and rushing cataracts, its snow-capped mountain peaks and mirrored lakes make it of surpassing interest. The lover of natural scenery may linger long over its beauties and its wonders.

From the geological point of view it is also of great interest, for here may be found rocks that range in age from the most ancient of which we have any knowledge to those in process of formation at the present moment. The superheated waters of the hot springs and geysers hold a large amount of rock-making material in solution, which is deposited about the openings of the springs on the cooling of the waters, and in this way building up a mass of great magnitude. These springs and geysers are constantly breaking out in new places, often on the borders or in the forests of living trees. The trees are killed at once by the hot water, and on becoming withered and dry, begin soon to take up the rock-making solution by which they are bathed, and thus to pass into the fossil state.

Conditions similar to these, or at least favorable to the preservation of fossil forests, appear to have existed from a remote time, for there is evidence to show that the fossil forests were preserved before the most active of the hot-spring phenomena were inaugurated. These fossil forests are located in the northeastern corner of the Yellowstone National Park, at a place known locally as Amethyst Mountain, or Fossil Forest Ridge. This is really a mountain some ten miles long, and rising nearly or quite 2,000 feet above the general level of the valley.

If it were possible to cut a section down through this mountain, as a slice is cut from a loaf of bread, there would be found a succession of at least fifteen fossil forests one above another. That is to say, at some remote day, geologically speaking, there grew a great forest, which was covered up by the ejected material from a great volcano, rivaling in size Mount Etna, that is known to have existed some miles to the north. The trees were entombed in an upright position, and under the action of silica-charged waters were fossilized. The action of the volcano ceased and quiet was restored for a sufficient length of time for a second forest to be developed above the first.

Then came a second outburst from the volcano, and this forest was buried and fossilized like the first, and so in turn have the dozen or more forests flourished and been ingulfed.

Then came the final quiet, the rumbling of the volcano ceased, and its fires were extinguished. But immediately the action of the elements began, and the wearing forces of rain and frost, acting through long ages, have carved out this mountain, in the heart of which may be read the story of its origin. This denudation appears to have been unaccompanied by any of the violent movements so often characteristic of mountain building, and consequently when the softer material is worn away from around the trunks, they stand upright in the exact positions in which they grew originally.

The first forest to be visited is in the vicinity of Yancey's, a stage station on the mail route from the Mammoth Hot Springs to Cooke City, Mont. It is about a mile west of the junction of the Lamar River and the Yellowstone, and on the middle slope of a low hill. As one approaches the locality, several trunks are observed standing on the hillside, which at a distance seem quite like the stumps of living trees, and even a nearer approach barely suffices to reveal their true nature, as they are covered with lichens and blackened and discolored by frost and rain. They are, however, veritable fossil trunks, standing upright on the steep hillside in the same positions in which they grew.

The largest trunk is thirteen and a half feet in circumference and about fifteen feet in height. It is considerably weathered and must have been much larger when living, for the bark is in no place preserved. The others—and there are dozens of them—are slightly smaller, and have been weathered down until, in most cases, only a few inches can be seen above the surface. So perfectly are they preserved, that each stump shows the annual rings as distinctly visible as in a freshly cut living tree; and even each tiny cell, with its fine and delicate markings, is absolutely perfect.

The next forest is some ten or twelve miles' distant, along the Lamar River, on the south side of which faces the Fossil Forest Ridge. In some places perpendicular cliffs, many feet in height, may be seen. These cliffs have worn away, leaving exposed huge trees, which may be observed from a distance of a mile or more from the valley, standing out in bold relief, as it has been aptly said, "like the pillars of some ancient temple."

A closer view shows these trees to be from four to six feet in diameter, and often twenty or thirty feet high, with their great roots running off into the solid rock. A great niche in the face of the wall marks the place from which one of these trunks has fallen. Some of the remaining ones appear just ready to fall, while others project but little beyond the face, showing that the mountain is filled with the remains of these trees.

A few miles down the river from these cliffs is the last, and, in some respects, the most wonderful of all the forests. It is exposed on a hillside too steep to support vegetation. The largest tree, which must have been a very king of its race, stands guard on the summit of the hill. It is twenty-six and one-half feet in circumference and fourteen feet in height, with roots as large as the trunks of ordinary trees, embedded in the solid rock. Just below this giant and forming, as we may suppose, the door posts of this ancient temple, are two trees nearly nine feet in circumference and about twenty-five feet high. From this point on the hillside are scattered about hundreds of trunks from one to eight feet in diameter, and from a few inches to twenty feet in height. One of the very largest was prostrated before it was fossilized, and is exposed for over forty feet. Both ends are concealed, and consequently its length cannot be determined. Almost all of these trees are perfectly preserved, even to the bark, which in some cases is five inches thick.

It should not, of course, be supposed that these trees are preserved entire, that is, with branches and leaves attached. They consist only of trunks and roots, but in the rocks all about the trees there are impressions of branches, leaves, and even cones and fruits, that must have belonged to them. By studying these impressions, as well as the beautifully preserved internal structure of the trunks themselves, a very satisfactory idea may be formed as to the appearance they must have presented while living.

Those with the thick bark were conifers like the sequoias or "big trees," of California, and quite likely were their direct ancestors. Others were like our common trees—that is, such as oaks, chestnuts, beeches, elms, maples, magnolias and lindens. The only living trees found in the vicinity of the fossil forests are pines and spruces and two kinds of cottonwood, a fact which teaches clearly that the conditions of temperature, etc., must have changed greatly since these wonderful fossil trees were living.

SOME STRANGE NURSING HABITS.

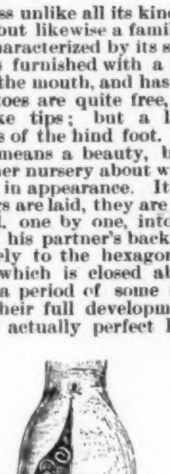
By R. LYDEKKER, B.A.Cantab., F.R.S.

WHILE the instinct of taking care of their progeny, whether these are born in the living state or first come into the world in the form of eggs, is more or less deeply implanted in the higher vertebrates, among the lower members of that great group the eggs and young are very frequently left to shift for themselves. Still this state of things is by no means universally the case; and we shall show in the course of the present article that certain amphibians and fishes exhibit structural modifications, for the purpose of protecting their eggs and young, which are almost or quite unparalleled elsewhere. Celebrated as they mostly are on account of their highly developed parental instincts, birds exhibit no instances where the body of either parent is specially modified for the purpose of carrying about either the young or the eggs after their extrusion. And we believe that the same holds good with regard to reptiles, although into the disputed question whether vipers afford protection to their young by allowing them to run down their throats we are not going to enter here, beyond confessing that we are inclined to trust the numerous observers who state that they have seen the phenomenon with their own eyes. With a certain group of mammals—the marsupials—the case is, however, very different, many of them, like the kangaroos, carrying their imperfectly developed young in a special pouch borne on the body of the female until sufficiently advanced to take care of themselves. In the females of certain other members of the same order, namely, some of the American opossums, the young are carried on the parental back, with their own tails tightly twisted around that of their mother; while bats carry their helpless offspring tightly clinging to their breasts; and the females of many lemurs bear them clinging transversely across the under surface of the lower part of their bodies. Now we shall find that among amphibians there are several instances where the eggs or young are carried about, either attached to the skin or borne in special receptacles; and as he knows that the relationship between the mammals and amphibians is much closer than any which exists between the former and either birds or reptiles, the

thoughtful naturalist cannot help being struck with this similarity as regards their nursing arrangements. Although not for one moment do we suggest that there has been any sort of inheritance in this matter, yet the coincidence is none the less striking.

Commencing with that group of amphibians represented by the frogs and toads, we find among these numerous instances of abnormal ways of protecting their young during the early stages of development, one of which has been known for nearly a couple of centuries, while many of the others have but recently been described. So far back as the year 1705, Fraulein Sibylla von Merian, in a work on the reptiles of Surinam, described a remarkable toad-like creature, in which the young are carried in a series of cells in the thick skin of the back of the female, which at this period has a honeycomb-like appearance. Till last year, when living examples were received by the London Zoological Society, the Surinam toad (Pipa americana), as the animal in question is called, was, we believe, only known in Europe by means of specimens preserved in spirit; and we have, therefore, been obliged to depend upon foreign observers for an account of its marvelous life history. As it differs from other members of its order with regard to its method of bringing up its family, so the Surinam toad is structurally more or less unlike all its kindred, constituting not only a genus but likewise a family group by itself. Externally it is characterized by its short and triangular head, which is furnished with a large flap of skin at each corner of the mouth, and has very minute eyes. The four front toes are quite free, and terminate in expanded star-like tips; but a large web unites the whole five toes of the hind foot. In any state the creature is by no means a beauty, but when the female is carrying her nursery about with her she is absolutely repulsive in appearance. It would seem that soon after the eggs are laid, they are taken up by the male and pressed, one by one, into the cells in the thickened skin of his partner's back; there they grow till they fit closely to the hexagonal form of their prisons, each of which is closed above by a kind of trapdoor. After a period of some eighty-two days, the eggs reach their full development and produce, not tadpoles, but actually perfect little toads. The reason of this is that tadpoles, which require to breathe the air dissolved in water by means of their external gills, could not exist in the cells, and, consequently, this stage of the development is passed through very rapidly within the egg. When ready to come forth, the young toads, which are usually from sixty to seventy in number, although there may sometimes be over a hundred, burst open the lids of their cells, and, after stretching forth their heads or limbs, make their debut in the world. Doubtless glad to be free from her charge, the mother toad thereupon rubs off what remains of the cells against any convenient stone or plant stem, and comes out in all the glory of a brand new skin. During the non-breeding season these toads become much flattened, and seem to pass the whole of their time in water.

THE PIPA.



Sub-caudal pouch of Syngnathus acus, with the young ready to leave the pouch. One side of the membrane of the pouch is pushed aside to admit of a view of its interior. Natural size. (From Gunther's "Study of Fishes.")

The Surinam toad is, however, by no means the only South American representative of its order whose nursery arrangements are peculiar, a considerable number of frogs and toads from the warmer regions of the New World having ideas of their own as to the proper method of bringing up a young family.

Among these are certain species nearly allied to the familiar tree frogs of Europe, but differing in that the females have a large pouch for the reception of the eggs. Unlike the kangaroos and other mammalian marsupials, in which the female has her nursing pouch on the under side of the body, these marsupial frogs (Nototrema) have this receptacle placed on the back, at the hinder end of which it forms a half open tunnel, with its aperture directed backward, although the pouch extends beneath the skin of the whole of the upper surface of the body. In this capacious nursery are deposited some fifteen or sixteen large eggs, which in due course develop into complete little frogs, without living tadpoles being produced, although at a certain stage the large eyes and long tail of a veritable tadpole are visible through the clear covering of the egg.

According to a communication recently made by Dr. Goeldi, of Rio de Janeiro, to the Zoological Society, the tree frogs of the genus Hyla, inhabiting that part of Brazil, show considerable diversity in regard to nursing habits, although none of them have any part of their own body modified into a nursery. One species, for instance, builds nests of mud on the shallow borders of pools, wherein the eggs and tadpoles are protected from enemies, while another kind lays its eggs in a slimy mass attached to withered banana leaves, the young remaining in this nest until they have passed through the tadpole stage. In a third species, on the other hand, the larval stages are hurried through before hatching, the female carrying a load of eggs on her back, where they remain until developed into perfect frogs. Not long since, a female of this species, thus loaded, was exhibited alive at a meeting of the Zoological Society.

It will be observed that in all the foregoing instances the female parent takes charge of the eggs, either on or in her own body, or in a specially prepared nest, as soon as they are laid; but there are two genera of South American frogs in which it appears that, while the eggs are left to themselves, the tadpoles are carried about by their mother. The members of the one genus (Dendrobates) are tree frogs from Surinam and Brazil, while the other species is from Venezuela, and belongs to the genus Phyllobates.

Here the tadpoles, which may be from a dozen to eighteen in number, affix themselves to the body of their mother by their sucking mouths, and are thus carried about. In the case of one species of the genus first named, it appears that this mode of locomotion is only resorted to when the water is drying up and the mother desires to convey her offspring to other pools; but in the other forms the attachment seems to be more enduring.

The female of Darwin's frog (Rhinoderma darwini), from Chile, has, however, "gone one better" than all her allies, for not only does she get her eggs and young safely carried about until they are fit to take care of themselves, but she has actually shifted the onerous task of taking care of them to her consort. Whereas there is nothing remarkable about the structure of the female of this frog, the male has a capacious pouch underlying the whole of the lower surface of the body, which communicates with the exterior by means of a pair of apertures opening into the mouth on each side of the tongue.

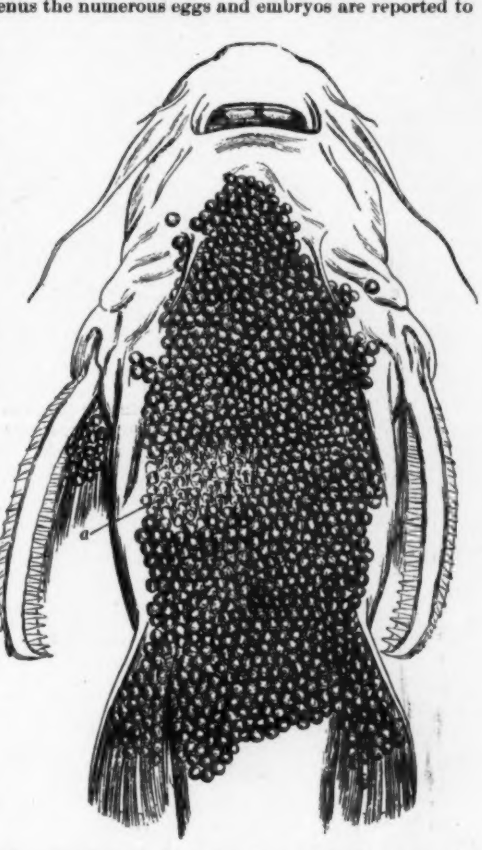
As soon as his partner has deposited her eggs, the male frog takes them in his front paws and transfers them to his mouth, whence they pass into the great nursing pouch, where they remain in perfect security till hatched into young frogs, which make their way into the world by the same passages.

Peculiar as is this method of taking care of the eggs, it is by no means without a parallel in the animal kingdom, although we have to go to the class of fishes to find anything approaching a similar example. Among the so-called catfishes (Siluridæ), the males of several species of the large tropical genus Arius take the eggs into their mouth, whence they are transferred to the capacious pharynx, where they remain until hatched. It is also said that among the freshwater fishes of the chromid family, the males of the typical genus inhabiting the Sea of Galilee take charge of the eggs in a similar manner. Indeed, among the comparatively few fishes that take any care at all of their ova, the charge almost invariably falls to the share of the long-suffering male, whose partner, having laid the eggs, appears to think that she has done quite enough in family matters, and is at full liberty to enjoy herself as she pleases.

Of the two definitely known instances in which female fish take care of their eggs, one occurs among the aforesaid family of the catfishes, in the genus Aspredo, represented by some half dozen species from the Guianas. In these fish, none of which exceed a foot and a half in length, the large eggs are carried on the under surface of the body of the female, where they form a shield-like mass extending from a short distance behind the mouth on to the pelvic fins. In some respects the position of the ova recalls a female freshwater crayfish in the breeding season; but a closer resemblance exists between the fish in question and the Surinam toad already described, although in one case the female bears her load upon her back, and in the other under her abdomen. In both instances the eggs are, however, pressed into the soft spongy skin, the female catfish affecting this operation by lying closely upon the newly-deposited spawn. Instead of being completely buried in closed cells, the eggs of the fish remain partly exposed, and are thus carried about till they are hatched; the rugosities then disappear from the skin of the abdomen of the parent, which resumes its normal smoothness.

Everybody who has been in the habit of partaking of whitebait will probably have occasionally observed among the contents of his plate a long, slender, bony fish, with a pipe-like nose, which has evidently no claim to kindred with its neighbors. This fish is a young representative of the pipe fishes, which, together with the so-called sea horses, so well known for their habit of curling their tails round the stems of seaweed, constitute a family especially remarkable for the variety and curious nature of their nursery arrangements. Among these an Oriental genus of small pipe fishes (Solenostoma) agrees with the fish last mentioned in that the female takes charge of the eggs. For this purpose she is provided on the lower surface of her body with a roomy pouch, formed by the coalescence of the pelvic fins with the skin of the abdomen. The inner walls of this pouch are furnished with long filaments, which aid in keeping the egg in position; and it is highly probable that after the young fish are hatched they are retained for some time by attachment to the walls of the chamber. In the true pipe fishes (Syngnathus), on the other hand, the task of looking after the nursery falls to the males, which are provided with a long pouch on the under surface of the tail, formed by a fold of skin arising on each side, and the two meeting in the middle line. How the eggs are conveyed into this pouch we are totally unaware, but when once there, they are completely inclosed by the junction of the edges of the two folds of skin, and thus remain till they are hatched into minute eel-like pipe fish, which soon make their way into the world by thrusting open the folds of the pouch. In the sea horses, the development is carried one stage further, the nursing pouch being completely closed along the middle line, and only communicating with the exterior by means of a small aperture at the anterior end, through which the eggs are by some means or other introduced, and by which in due course the young make their escape. Certain pipe fishes (Doryichthys) differ from the ordinary forms in that the males have the pouch situated beneath the abdomen instead of under the tail; and it is not a little remarkable that in certain allied genera (Nerophis, etc.) the eggs are simply attached to the lower surface of the abdomen of the male without the development of a pouch. We have thus an excellent instance of the evolution of a special organ, so far as the abdominal pouch is concerned; but it would seem highly probable that the caudal pouch of the allied forms must have been independently evolved, in which event we should have a remarkable example of parallelism in development.

Although many fishes retain their eggs within their bodies until the young are hatched and attain a considerable size, we are not aware that any others have special arrangements for carrying about their eggs after extrusion, with the exception of the aberrant lung fish (Protopterus) of tropical Africa. In this genus the numerous eggs and embryos are reported to be nursed in a long gelatinous pouch attached to the sides of the back of one of the parents, although which of the two is charged with this office does not appear to be ascertained. Several kinds of fish are, however, in the habit of constructing nests for the reception of their eggs, while a few take advantage of other animals for their protection. For instance, the females of the small roach-like fishes, of which the Continental bitterling (Rhodeus amarus) is the only European example, have the oviduct periodically prolonged into a tube of considerable length, by means of which the eggs are introduced within the shells of living freshwater bivalve mollusks, where they remain secure from foes until hatched. Among the nest-building species the most familiar are the bullheads (Cottus), sticklebacks (Gastrosteus), and lump-suckers (Cyclopterus), in all of which, as in the other instances, the nest is formed and guarded by the male fish. In the sea-stickleback the nest is a large structure composed of pendent seaweeds, tightly bound together into a pear-shaped mass by means of a silk-like thread. When the eggs are safely deposited within its interior, the male fish immediately mounts guard, and has been known to continue uninterruptedly at his post for upward of three weeks. Should any damage happen to the nest, so that the precious eggs lie open to the attack of any predaceous wanderer, the janitor forthwith sets to work with the greatest energy to repair the damage, poking his nose into the structure, and rearranging the materials till all is made right. Nests are also made by the freshwater species, and guarded with the same care; the male frequently stirring up the eggs with his snout, and often keeping up a fan-like movement of his fins for the apparent purpose of insuring a con-



Abdomen of Aspredo batrachus, with the ova attached; at a, the ova are removed to show the spongy structure of the skin, and the processes filling the interspaces between the ova. Natural size. (From Gunther's "Study of Fishes.")

tinual change of the water. Many other fishes construct more or less elaborately formed nests, but even when no nest is built, the males are in the habit of mounting guard over the eggs; this being the case with the bow-fin (Amia calva), so abundant in the lakes of North America.

Such are some of the chief instances among amphibians and fishes where special arrangements—either of structure or of habit—are made for the protection of the eggs and young; and although these bear but a small proportion to the cases where the latter are left to themselves, yet they are sufficient to show that in these respects these two animals present peculiarities unknown among other vertebrates. Why such special arrangements have been evolved in these cases, or whether the groups in which they occur have any advantage in the struggle for existence over their fellows, are questions which, for the present at least, must remain unanswered.—Knowledge.

A CAT SHOW IN NEW YORK.

New York has had lately a new sensation, a cat show. Although the first, it was given the qualifier "annual," because its projectors had faith enough in its success to believe that it would take its place along with the trio of successful live stock exhibitions held here every year—those of the horses, dogs and poultry. And the way Society (with a big S) has taken to this latest "function" warrants the faith of the originators. Some of the latter were not exactly tyros in feline shows, the superintendent, T. Farrer Rackham, having had much to do with similar affairs in England. There, such shows have become very popular, and entries have been large, and interest keen. There, too, as well as in other European countries, the breeding of cats has received much more attention than in this country. Some of the finest specimens exhibited here were imported.

There is no regularly organized association back of this show as there is back of the horse, dog and poultry shows. Those interested in breeding and importing took this initiative step to bring the desirability of pussy as a pet more prominently before the public. As the genial Chas. Chamberlain, the venerable press agent, put it, "the cat is to the parlor what the dog is to the kennel." He says that these shows in England have assumed large proportions, and there is no reason why they should not be a success in this country.

To many people, a cat is simply a cat, without regard to breed or other distinguishing characteristics. Among farmers, the chief requisite is that they must be good mousers and ratters. We sometimes hear of such distinguishing terms as Maltese cats, tortoiseshell cats, etc.; but among people at large, little is really known about the different breeds of cats. This is not a difficult subject to master, as the number of breeds is not large, and the distinguishing characteristics are easily learned. Related as she is to the king of beasts, the lion, tabby is deserving of more attention.

Dr. Huidekoper, an expert on cats, and one of the judges of the show, gives these as the good points of a cat regardless of its class:

"The head should show breadth between the eyes and be strong boned. The eyes should be round and open. The nose should be short and tapering. The teeth should be good and the claws flat. The upper leg should lie at closed angles; the lower leg should be straight. The foot should be small and round. A good cat should be deep chested, but light framed. The neck should be slim and graceful, but firm; the ears medium in size, with rounded points. The croup should be square and high, the tail long and tapering."

Cats are divided into two general classes—long haired and short haired—and each of these is divided into different breeds. All of those usually seen belong to the short haired class. The latter includes tortoiseshell, tabbies of various colors—brown, dark gray, silver, blue, red, black, white and combinations of these colors—Australian and Manx cats. The long haired includes the Persian, Algerian, Angora, and tabbies of different colors. The latter class appear, to the non-professional at least, to be an unkempt lot, and must require a great deal of care to keep them in anything like presentable condition.

It may be news to many, but there are many persons engaged in the breeding of cats, some of whom claim to sell hundreds of animals yearly. The business of importing the different breeds is also carried on. Some of these are valued at what looks like ridiculous prices, at least two in the show being priced at \$1,000, several at \$300 to \$500. A still larger number in the neighborhood of \$100, and so on down, a very few being priced as low as \$5. As cats are very prolific, if they become a fad, as the interest manifested would seem to indicate, cat breeding ought to become a profitable industry. Many city people are so situated that they cannot well keep dogs or other pets, but can keep a cat. There are establishments that take the pets to board during the absence of the owners. There are veterinarians who make a specialty of cat diseases, which, by the way, are few. A book is devoted to pussy and her language. A photographer makes a specialty of taking her picture. A veterinarian has written a guide to the classification and varieties of cats, and a treatise upon their care, diseases and treatment. Who says that the cat is a person of no importance—a backyard prowler, a giver of unsolicited midnight concerts? She is susceptible to right influences; is largely what her surroundings make her, and although one of the hardest animals to train, may be taught many accomplishments.

In this show, competition is open to all. The entrance fee was \$1 for each cat or pair of kittens. Cats must be correctly described by, and be the property of, the exhibitor. Rules governing exhibitors were strict. Prizes given were \$5, \$3 and \$2, respectively, the fourth being highly commended; the entries in most classes were not large, there being 183 entries in all.

In addition to the regular prizes, many special prizes were offered, some of them quite valuable. The caging and feeding was done by Spratt's Patent, which does this work for all the leading poultry and dog shows in the country, and, needless to say, it was admirably done. The attendance was good, and considerable interest manifested.

Among cats attracting special attention were the Manx, from the Isle of Man, a tailless breed. Their rarity renders them more conspicuous. Old Gold, owned by T. Farrar Rackham, took the first among these.

Grover b., a \$1,000 short haired gelded, in a white and gilt cage with a colored attendant, attracted much attention, but took third prize. He is said to have his high chair and plate at table, and to behave with all the decorum of high bred royalty. He weighed 23¼ pounds.

Another gelded cat has as companions in his cage two cages of birds, and all seem to get along amicably together. Grover Cleveland, a short haired gelded tabby, attracted much attention, possibly on account of his name, but he was a beautiful cat for all that, and took first.

In none of the breeds does there seem to be an established color. The Angoras are long haired, resembling somewhat in appearance an Angora goat. Mr. Rackham is of the opinion that this breed has been manufactured in France, instead of coming from the eastern countries like the Persians and others. He also says that the Australian cats are too tender for this climate.

An orange and white Angora, Ellen Terry, with seven kittens in a large white basket, was much admired. Several of the gelded cats weighed 25 pounds, and one claimed the weight of 30 pounds. A trio of black gelded tabbies made a fine showing. There were several Trilbys and one Ben Bolt. One short-haired he cat had 22 toes. Another was said to have seven toes in front—probably on each foot. Still another was born with three legs and was valued at \$500.

Frances Cleveland was a steel Australian and took third prize, while her daughter, Midget, a fawn Australian, took fourth. Among the tabby she cats with kittens was Kitty, a pure white, with four beautiful kittens, but she took second prize. The question repeatedly asked was, "why didn't she get first?"—which shows probably that the public is not yet educated up to the fine points in cat breeding.

Columbia was a fawn Australian with two kittens, Yale and Harvard. In one row there were four generations of cats, the grandmother being only four years old. Mrs. Ella Wheeler Wilcox exhibited an imported Persian, Madam Ref. The long haired cats were valued much higher than the short haired, though the prizes were the same.

A prize was offered for the homeliest cat, which must, however, be sound and healthy, and this brought out a trio that ought to delight the heart of the donor of the prize. The S. P. C. A. had several cats which they had rescued from the street, and their comfortable, cleanly appearance was a good argument for the existence of this society.

Several ocelots, civets, and wildcats were exhibited, and were viewed at a distance in an awed sort of way except by one old lady who had a supply of catnip in her satchel which she persisted in forcing into their cages. These animals bear a strong resemblance to their domesticated cousins.

One of the most interesting features of the show was the exhibit of mounted specimens of the cat family, or felidæ, numbering toward 200 specimens, made by C. G. Gunther's Sons, furriers, New York. It embraces one or more specimens of nearly every one of this extensive order of carnivora, and all were mounted in the highest style of the taxidermist's art. It was an instructive exhibition. More than 1,000 dressed skins of all kinds were also shown.

It is reported that steps will be taken to organize an association for the advancement of cat breeding, and that the lovers of these pets will arrange for yearly exhibitions. The one just held was well supported, and the projectors have reason to feel gratified over the outcome of their venture. C. S. V.

—Country Gentleman.

THE MONITOR AMPHITRITE.

This coast defense vessel was added to the commissioned fleet on April 23. She is a low freeboard monitor with two steel barbette turrets. Her keel was laid at the Harlan & Hollingsworth yard in Wilmington, Del., in 1874, and she remained incomplete until March 3, 1887, at which time plans for her alteration and completion were made. In August, 1889, the rebuilding was begun. This vessel is smaller than the Puritan and is not so heavily armored. Her length on the load water line is 259 feet 3 inches, and her extreme length is 261 feet 6 inches. Her breadth is 55 feet 10 inches and her draught 14 feet 6 inches. The total displacement is 3,990 tons. She has twin screws so placed under the stern as not to be exposed to the fire of an enemy's guns. The maximum indicated horse power is 1,600, her engines being of the inclined compound type. The coal capacity of the vessel is 250 tons, and steaming at the rate of about 9 knots she could cruise for 9 or 10 days and cover about 2,500 miles. The armor of the vessel is 9 inches thick, tapering to 6 inches below the water line. She has a protective steel deck 1¾ inches thick, and is provided with a ram. The thickness of the turrets is 7½ inches, while the steel barbettes surrounding the lower part of the turrets are 11½ inches thick. The turrets are operated by hydraulic machinery. The vessel carries four 10 inch breech-loading rifles and two 4 inch rapid firing guns. Besides this there is a secondary battery of two 6 pounders, two 3 pounders and two Hotchkiss revolving cannon. The vessel has no torpedo tubes.

GAS TRAM CARS IN DESSAU.

A line in Dessau, Germany, which has replaced its horse cars by gas motor cars, is about 2¼ miles long, and opened with the new service last November. The cars are driven by a gas engine having two cylinders, connected up to the same shaft, and lying opposite each other under one side seat. These are connected with a shaft carrying a fly wheel and a gear wheel, which through an ingenious friction gearing allows the car to be stopped and started, and run at varying speeds. Gas is carried in cylindrical tanks, similar to those used for gas lighting on railroad cars. These tanks are filled at a station at the end of the line, where a pumping engine, and storage tanks holding compressed gas at eight atmospheres are located. There are 9 cars of the smaller type used upon this line, having 12 seats and 15 standing places. There is also a 7 H. P. motor of the Duetzer system, having three tanks, carrying sufficient gas for a trip of 12 miles. The ignition is made by an electric spark, and is noiseless, and the exhaust is not apparent. The arrangement of the machinery is such that the cars present a sightly appearance, none of the machinery being visible.

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TABLE OF CONTENTS.